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MAY 2001

Focus

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The MyCn18 planetary nebula.

Science and Creation

The riddle in the skies

Vast in size and deeply mysterious in origin, the universe stands as the greatest challenge to the ambitions of modern science. Cosmologists from around the world believe the secrets of creation may be just around the corner, and have spent the last decades enriching and perfecting their accounts of the big bang. But are they really as close as they think? Can science ever answer the eternal question: why something rather than nothing?

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IN THIS ISSUE

Imagination

Let us begin at the beginning, at time zero. The universe is born in unknown,possibly unknowable circumstances. Billions of years later, since the most ancient times, human beings have marvelled at the night sky and sought answers to profound questions there. The frontiers of cosmology explored in this issue lie far beyond the human scale, giving free rein to the imagination (pp. 16-37).Myths of enchantment and terror have always accompanied the story of creation.In Latin America,they are also nourishing a new wave of storytellers, including the Colombian Nicolás Buenaventura (pp. 41-43).

Exclusion

As part of the war on drugs, Colombia's coca crops are being sprayed with a herbicide that is threatening the health of close to half a million people, driving them off the land (pp. 10-12).Customs, poverty, sexual violence continue to close the school doors to millions of young girls, notably in Africa and south Asia (pp. 13-15).After civil war, dictatorship or genocide, grievously wounded societies have set up truth and reconciliation commissions as a path to pardon and recovery. Countries as far apart as Bosnia, Canada and Mexico are considering the option (pp. 38-40). To give those excluded from the information world a voice, participants at the World Social Forum in Porto Alegre adopted the Internet as their chief weapon for taking on the major media groups. To end,Mark Anspach draws parallels between the use of ritual sacrifice in primitive societies to end internal conflict and the anonymous victims —another kind of sacrifice—ushered in by the cold logic of the modern marketplace (pp. 47-51).

Abandoned, Christina, two-months, receives care in a state hospital.

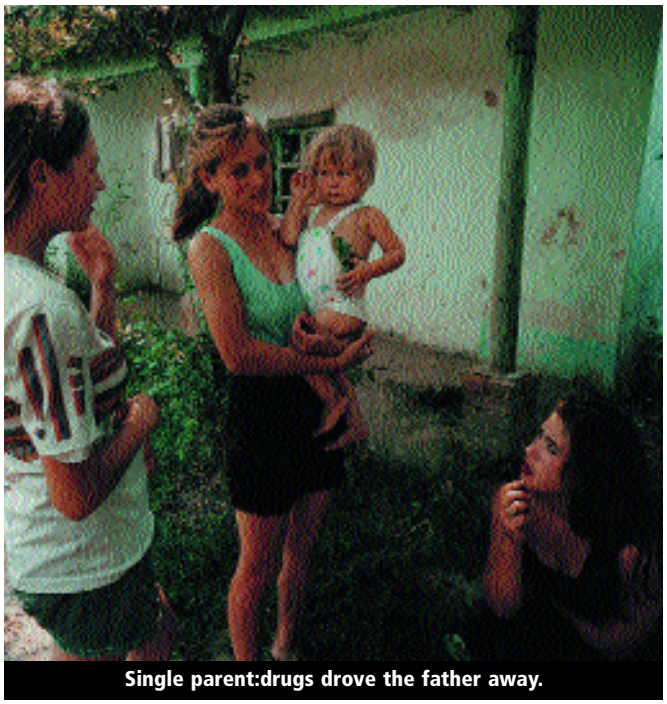
The deep-seated changes that have occurred in our country in the past 15 years have given some people the chance to strike it rich and dragged others into poverty

I, Galina Komarnitska, nurse in Kiev

PHOTOS BY REINER RIEDLER;TEXT BY GALINA KOMARNITSKA

GALINA KOMARNITSKA IS A UKRAINIAN NURSE.REINER RIEDLER,A 33-YEAR-OLD AUSTRIAN PHOTOGRAPHER,PLACES SPECIAL VALUE ON THE "ETHICS OF SEEING." IN RECENT YEARS, HE HAS COMPLETED SEVERAL LONG-TERM PROJECTS IN EASTERN EUROPE

The people in these pictures inspired me to share with readers from other shores scenes from my everyday life. I'm often faced with distress, but there's still time for dreaming



Single parent:drugs drove the father away.

often think back on this day last year. It was May 27,the day after my birthday. I had just turned 28 and didn't really feel like going to work, but, as the Ukrainian expression goes, "*Hiba hotchech,mousych!*" ("You must,whether you like it or not!").

Before the ambulance set off on the streets of Kiev that morning, I ran down the usual checklist. The doctor filled out the call sheets, a co-worker checked the equipment. When everybody was ready, we hit the road!

Our rescue squad answers all kinds of calls, but most of the time we deal with cardio-vascular and gastric diseases, various kinds of poisoning and,of course, trauma.

That day, from ten in the morning till four in the afternoon, we drove through the city following a well-worn pattern. I don't know if the capricious weather that spring had anything to do with it, but there were a lot of heart attacks. We treated some patients at home and brought others to the nearest hospital.One man had dropped a 200-litre barrel on his leg and paid for his lack of caution with a broken foot.

Then we had to deal with a car crash caused by two reckless drivers. One was suffering from brain trauma and a chest injury. The other was walking around desperately waving his arms, trying to convince us that he wasn't speeding and that he hadn't been drinking "too much"—just a few beers—even though drinking and driving are against the law in Ukraine.

At around 5:30 p.m.,we received a call.A man,we were told,showed no signs of life. We rushed to the scene. He was homeless, dead drunk and incapable of the slightest reaction. And there we were, three young women—I was the oldest—lifting this poor, dirty "divine creature" on to a stretcher and

A gripping story.

I, Galina Komarnitska, nurse in Kiev

All bundled up for school in the village of Mikulicin.

carrying him to the ambulance. Our driver helped us, of course, but no man,much less a woman,can feel fulfilled by this kind of work.

We are all children of God, and no one has the right to judge that homeless man. Who knows why he's on the streets? The deep-seated changes that have occurred in our country in the past 15 years have given some people the chance to strike it rich and dragged others into poverty. And unfortunately, those others are the great majority.

But something else baffles me. We used to have a special ward and rehab centres staffed by sturdy men for this kind of case. That was indispensable: in Ukraine, "drinking" does not mean the same thing as in the west. But recently, a few bureaucrats decided to get rid of these centres, probably for financial reasons. And they gave paramedics the responsibility for "collecting" drunks.

Ours woke up and decided that now was the time to "get to know each other." He grabbed me by the leg and started

Companionship in a retired people's home.

I, Galina Komarnitska, nurse in Kiev

In Ternopil,a vendor seeks to protect her wares against the blustering winds.

pulling me towards him. I screamed, the driver stopped the ambulance, came to my rescue and calmed him down with a . . . heavy object. The incident was quickly over, but my hands shook for a long while. That time, we were lucky. Our "customer" fell asleep without moving or making noise. We had to take his pulse to make sure he was still alive.

It was 20 kilometres to the hospital and as many for the way back. Being stuck in traffic jams gave me time to wonder about a few things. For example, why go through 10 years of school and several years of training—three for a nurse, six for a doctor — just to pick drunks up off the street? At these times I feel as though my profession, knowledge and eight years' experience are useless. It's hard to escape a deep sense of disappointment.

But you can't spend your time brooding. In two months, I'll be on vacation with my boyfriend on the shores of the Black Sea. I used to go there with my parents, but that was such a long time ago, it seems like a dream.... We want to stop at Feodosiya,the town where the seascape painter Ayvasovsky once lived. Then we'll head further south, to Sudak and Novi Svet, where Prince Galitsin had tunnels dug to grow the local mushrooms that won a medal at the 1900 World Fair in Paris. Close by, there is a cave where the world-famous opera singer Chaliapin used to give impromptu concerts. And then, somebody told me about a grove of juniper bushes whose fragrance is so subtle that words cannot describe it.I am familiar with the scent of roses, lilies and lavender, but that of juniper is still unknown to me.

I'm also planning to see the Toplovski monastery, where the martyred Saint Paraskeva lived. After the October Revolution, the Soviets set up the Besboshnik ("The Atheist") kolkhoz [collective farm] on the monastery's land, and the three sacred sources dried up. In the early 1990s, when the property was restituted to the Orthodox church, the spring began to flow again.Now, people come from everywhere on pilgrimages to drink and touch the water. I know all that from accounts and pictures. But now that I believe in divine providence, I'm looking forward to seeing it with my own eyes.

But the day is not over. Another call took us to a dead-end near the train station, where someone found an unconscious boy. The siren wailed. We rushed into the unknown, to a place with neither a street nor a house. It was almost midnight. ■

Key figures

Population		**50 million**
Surface area		**604,000 sq.km**
Adult literacy rate		**99.6%**
Life expectancy at birth		**69 years**
Population lacking essential food and non-food needs		**50%**
GNP per capita (US$)	**1989**	**2,610**
	1992	**1,820**
	1999	**750**

Sources: World Bank, UNDP, 1998, 1999.

I used to go to the Black Sea with my parents, but that was such a long time ago, it seems like a dream.
. . .

In ticklish reptile company.

Toxic rain kills more than the coca

The so-called "war on coca" in Colombia, backed by the United States, is destroying jungles and forests, and threatening the health of half a million peasants and indigenous peoples

NELSON FREDY PADILLA CASTRO

CHIEF INVESTIGATIVE REPORTER OF THE MAGAZINE CAMBIO AND CORRESPONDENT FOR THE ARGENTINE DAILY CLARÍN

A Colombian national police plane sprays poppy crops in the state of Huila.

At first sight, a coca leaf is nothing more than an ordinary light-green leaf that grows on a rather ugly bush.But if you hold one up to the light,it turns yellow and a system of veins appears that seems to carry a substance towards the centre. This is the narcotic over which 15,000 leftist guerrillas and 8,000 far-right paramilitary troops are fighting in Colombia. Each side's secret military structure rests on the underground economy of growing and refining coca leaves. Drug trafficking has set off a war in Colombia just as diamonds have in Sierra Leone.

Over the last 15 years, trafficking has turned Colombia into a top national security issue for the United States, the world's largest consumer of cocaine. As such, the U.S. has a direct influence on Colombia's fight against drugs through hefty budgets, military hardware and other aid, along with the threat of political and economic sanctions. American involvement has increased to the point that the so-called Colombia Plan,the main programme of President Andres Pastrana's government, now receives $1.3 billion in U.S. aid.

According to Pastrana's reasoning, if all the coca planted in the country is destroyed, there will be no money left to fight the war, allowing peace to be negotiated with the outlawed groups. No more cocaine would be sold on the streets of American cities. Washington supports this scenario. To achieve the goal within five years, a military offensive was drawn up, including the creation of three anti-drug battalions and a fleet of planes to spray the plants with a poison called glyphosate.

Is this a good thing? Environmental NGOs such as Acción Andina see it as a scorched-earth policy and the European Union criticizes the programme because it provides no long-term solution for the survival of communities that live off growing coca. The government says at least half a million people—450,000 peasants and 50,000 indigenous people—depend directly on the crop for their livelihood. Yet last December, the authorities began large-scale secret spraying of coca plantations with glyphosate, a pink liquid herbicide used against all crop diseases.

A desolate scene

Colombian officials from the antinarcotics directorate of the national police say 30,000 hectares of coca were sprayed with the poison last January. Glyphosate has been used since 1984 to kill marijuana plants. A decade later, the government authorized its use in the Andean highlands to eradicate a violet poppy whose buds produce a thick white liquid that forms the rubbery substance from which opium, morphine and heroin are refined.

Although glyphosate is banned in several U.S. states, including Florida, where it was rejected as a way to eradicate marijuana plants in the Everglades region "because of its unclear effects on the environment," the Colombian authorities cited research funded by the country's national farming institute that ensures the chemical does not pose a health risk to humans and is only slightly toxic for animals and plants.

To appease the growing chorus of

criticism, the authorities promised to implement an environmental management plan that would limit use of the chemical to destroying illegal plants, without harming the rest of the environment or people. Six years later, this plan remains a draft document on the desk of environment minister Juan Mayr. Meanwhile, the poisonous rain has now been sprayed over more than 300,000 hectares of jungle and forest.

National watchdog bodies such as the office of the ombudsman have since shown that glyphosate causes irreparable harm to people and the environment wherever it is used. The ombudsman's most recent study was of the Colombia Plan's launch in Putumayo province, which borders Ecuador and where half the country's coca is grown.

Representatives of four indigenous communities protested last January 11 against the damage glyphosate had done to their staple crops (maize, bananas, manioc and other vegetables), their health and the lives of their animals. A delegation from the ombudsman's office, along with experts from the UN High Commission for Refugees (UNHCR), visited the area between January 15 and 25 and reported on what they described as a "desolate scene." There had been "indiscriminate destruction of the jungle, legal crops, medicinal plants and fish-ponds. There is clear evidence that wildlife has fled, rivers are contaminated and production in the region has fallen."

Skin and gastro-intestinal problems, fevers, headaches, nausea, colds and vomiting were common among the inhabitants, the mission observed. The police and the national anti-narcotics authority, which are in charge of the spraying, argue that the herbicide is dropped very accurately thanks to satellite imagery and aerial photography that pinpoint the exact location of the coca plantations. But wind and the weather means that the chemical can overshoot the fields by up to 150 metres, the ombudsman said.

The social consequences of this are huge. Villages have been abandoned and about 20,000 people have fled their land in the face of the military campaign against coca. Anticipating the arrival of refugees, the UNHCR set up camps in the border area of Lake Agrio (Ecuador) halfway through 2000. "The evidence is strong, so we're calling for an immediate halt to the spraying and for the compensation of the victims whose livelihoods are seriously threatened," says ombudsman Eduardo Cifuentes. There is no effective coordination, he observes, between the various state bodies involved in the government's anti-drug campaign and those whose job it is to protect the environment.

"We're the embittered children of this damn coca thing. It's left some of us ruined and others in jail or in the cemetery."

Peasants like Aicardo Loaiza have to live in the 35-degree heat of the coca plantations and under the constant threat of the guerrillas, the paramilitaries and the crop-spraying planes. Loaiza, 48, came to Putumayo in 1968 drawn by fortunes to be made out of rice growing. Today, he has a wife, 13 children and has had enough of growing coca "for the big shots." He lives in the Santana district and is trying to persuade 500 of his neighbours that the only solution is to sign an agreement with the government to pull up the coca plants by hand themselves in exchange for an end to spraying and subsidies to grow legal crops.

"Look at us. We're the embittered children of this damn coca thing," he says. "We've been doing it for 20 or 30 years. It's left some of us ruined and others in jail or in the cemetery." He has the hands of an expert coca gatherer, a *raspachín*, as the drug traffickers call them, and they were the first to sign an accord with the government to destroy the coca plants "voluntarily and not under threat of the poison." For Loaiza, this is the only solution.

In recent months, 5,000 families—small-time growers with no more than 10 hectares of coca—have chosen this path. These are people who harvest the leaves between three and six times a year, pack them in bags and take them by river to the nearest processing plant. Amid or alongside the coca bushes, they grow bananas, manioc, maize, fruit and medicinal plants. If these crops are ▶

Half the country's coca plantations are located near the southern border.

COCAINE IN COLOMBIA

Colombia is the world's main producer of cocaine, coca paste and cocaine base. U.S. State Department figures from March 2000 say 140,000 hectares in Colombia are planted with coca bushes, producing about 580 tonnes of pure cocaine a year. Coca does not hold the same cultural importance in Colombia as it does in Bolivia and other Andean countries, although it has always been used for medicinal reasons, especially by the Indians living in Amazonia. But it is still not legal to use it, as it is in some parts of Bolivia. ■

sprayed from the air, the families' lives are destroyed in one stroke.

The agreements signed by the farmers stipulate that they must uproot all their coca plants within a year in exchange for being included in alternative development schemes. The deal works in Loaiza's village, where a factory to process palm-oil and fruit has been set up to enable the villagers who carry out the deal to earn a living.

This would seem to be the ideal solution for getting rid of coca without further damaging the eco-system, at least in the eyes of peasants and environmental organizations. But the funds set aside in the Colombia Plan for such alternative development are small compared with the amount for military operations and spraying. The U.S. is supplying only $300 million for social and economic substitution compared with $1 billion for military purposes.

Children playing in a sprayed coca field in January 2001.

© Ricardo Mazalán/AP/Boomerang, Paris

A new strategy?

Another obstacle to the agreements with the peasants is that they do not attract the big-time coca growers, those who have 100 hectares or more planted, with hidden arsenals to protect them. Gonzalo de Francisco, an aide to President Pastrana, runs the Colombia Plan in Putumayo province. There, he says, "the government has no choice but to use military means and aerial spraying."

The head of the national anti-narcotics authority, Gabriel Merchán, told the *Unesco Courier* that "the drug-traffickers are the ones who damage the environment and nobody protests against that. The arguments are all about condemning the use of glyphosate despite the fact we've used it in accordance with national law and international rules." Environment minister Juan Mayr agrees, and both men insist the "drug traffickers have deforested 600,000 hectares of jungle and forest land and use 75 chemicals more poisonous than glyphosate."

Tomás León Sicard, a Colombian National University researcher and expert on the environment and development, thinks the parties involved should stop being politicians for a moment and get to the heart of the matter. This is urgent, he says, because

"The drug traffickers are the ones who damage the environment and nobody protests against that."

the fighting is taking place in very fragile and biologically diverse rural eco-systems, such as Amazonia. He calls on the combatants to save them since "there is enough room for everyone on land in the agricultural regions."

Implementation of the Colombia Plan, massive spraying and peasant protests have spurred the environmentalists to intervene. After a lot of pressure, the U.S. State Department recently admitted for the first time that "errors" were perhaps being made in the spraying operations and that a new eradication strategy might be considered if an effective one could be found.

Court action

For the time being, the figures used by the anti-narcotics officials themselves show that the more land is sprayed, the more new land is planted with coca. The plantations simply move from one province to another because the conditions for growing it are still all there—poverty, unemployment, absence of the state, social conflict and a growing demand for cocaine from foreign markets.

In these circumstances, one non-repressive solution is the law. Environmental lawyers Claudia Sampedro and Héctor Suárez have persuaded a Colombian administrative court to allow a demand from a grassroots group for the government to take responsibility for the damage the spraying has done to the environment and to people.

"For the first time, Colombian society is using the law to check that the government respects the environment, not just by recognizing the damage caused, but by suspending the spraying and taking preventive measures," says Sampedro, an expert in international environmental law.

How can the authorities have been spraying for more than 15 years without taking any steps to protect the environment? Who will take responsibility for that and for the irreversible damage that has been done? The court will try to answer that very soon because the debate is moving onto

+ ...

http://usinfo.state.gov/regional/ar/colombia
http://www.presencia.gov.co
http://www.mediosparalapaz.org

When girls go missing from the classroom

Millions of girls are not making it into school, despite a concerted international movement to push the cause forward. In some African countries, the gender gap is even widening.What's gone wrong?

CYNTHIA GUTTMAN

UNESCO COURIER JOURNALIST

In Ethiopia, girls are sometimes abducted for marriage when they're no more than eight. In West Africa, they're recruited from poor rural families to work as domestics in coastal cities or neighbouring countries. In South Africa, a recent report by Human Rights Watch warns that sexual violence and abuse is hampering girls' access to education.And in Afghanistan,they've simply been barred from school under the Taleban regime.

Customs, poverty, fear and violence: girls still account for 60 percent of the estimated 113 million out-of-school children, and the majority live in sub-Saharan Africa and South Asia. In 1990, faced with a deteriorating educational record in many countries, the major development agencies and 155 national governments rang the alarm at a high-profile conference in Jomtien, Thailand.Launching the Education for All initiative, ambitious targets were set, notably to get all children into school within ten years, stressing that "the most urgent priority" was to ensure access to, and improve the quality of education for girls and women. Ten years later, in Dakar (Senegal), the world community had to face up to the fact that "gender discrimination continues to permeate education systems" and that "little progress has been made in increasing girls' participation in basic education." This time round, they set 2015 as the date by which "all children,particularly girls . . . complete free and compulsory primary education of good quality." More boldly, they pledged to eliminate "gender disparities in primary and secondary education by 2005."

For Christopher Colclough, a professor at the Sussex-based Institute of Development Studies (IDS), there is "no chance whatsoever"of reaching the 2005 target.In sub-Saharan Africa, where he has led a nine-country research project[1] to diagnose ▶

Girls account for an estimated 90 percent of child domestic workers. Few have a chance to attend school.

© Shehzad Noorani/UNICEF, New York

constraints to schooling and propose policies to improve outcomes, the gap between girls' and boys' primary enrolment rates has increased in some places. "Governments recognize that girls' education is incredibly important but their policies to tackle it are usually inadequate," says Colclough, suggesting a "*de facto* political unwillingness" to deal with the problem. Secondly, he notes "if you have a situation where women and girls are discriminated against in society and not all children are in school, it follows almost as night follows day that girls will be kept out of school most."

Not that the task is easy. In many countries strapped by debt burdens, the goal appears more elusive than ever, with families bearing increasing costs for educating their children. "A lot of girls are dropping out of school or not being sent at all because of the poverty of parents," says Peninah Mlama, executive director of the Forum for African Women Educationists (FAWE), a partner in the IDS study. "Traditional cultural attitudes are still very strong, especially in rural areas. The little money parents have to scrounge for sending children to school is seen as too big an investment to risk on the girl child." To make matters worse, the HIV/AIDS pandemic is cutting into a generation of young adults—in Swaziland, it is estimated that three to four teachers die every week of AIDS. In the absence of a breadwinner, girls are the most likely to be denied access to school to head a household.

Hidden costs

While there is no magic bullet for solving the quandary, there is little left to discover about why girls stay on the sidelines, starting with the number one factor, poverty. "Although we can't underestimate the role of culture, even in the most conservative societies like rural Yemen, the vast majority of families want to send their children to school, and they will do so if you reduce the costs," says Carolyn Winter, of the World Bank. The problem lies in the complex weaving of "social and economic forces that overlap and strengthen each other," Colclough underlines. Waiving school fees for example, does not address the question of how to replace a girl's valuable labour in the home and the fields, nor the profound bias in some countries against educating daughters. Nor does it recognize the hidden costs of schooling, from clothing to textbooks. Recruiting more female teachers, an indisputably positive influence, is only truly beneficial if parents are informed of their presence, if textbooks are revised to cut out stereotypes and training tackles attitude questions. In all the countries where they conducted research, the IDS team found that teachers believed that boys were more intelligent….And when chores have to get done like cleaning the classroom, girls are naturally expected to oblige.

"If there is one lesson we have learned, it's that there is no single quick fix, but there are usually to two or three actions together that are catalytic," says Mary Joy Pigozzi, a senior UNICEF education advisor. Two are proven musts: getting parents and communities involved in schools, and improving quality. Most importantly, says Pigozzi, quality has be thought about in "engendered" terms through an "affirmative action" approach that takes into account where the learner is coming from: "You have to understand that girls may get less protein than boys, that communities raise girls to have different expectations of themselves. Then you have to look at the quality of the learning environment to address issues such as safety and sexual harassment, and the whole teaching-learning process."

"You have to understand that girls may get less protein than boys, that communities raise girls to have different expectations."

Understanding the critical things that make a difference is one part of the story, the other is how countries go about changing their ways. "Nearly every single policy document mentions girls' education, it's almost as if it's the politically correct language to use," says Mlama. "But governments don't have the capacity and commitment to really do something." Many education ministries, for example, have set up gender or girls' education units, "often staffed by one or two people who don't have the skills and capacity to influence overall educational policy." In meetings on education reform, she continues, "they'll be called in towards the end of the process or at the final meeting with donors."

Addressing the bias

Outside pressure is founded upon irrefutable evidence: educating girls and women has a significant impact on reducing poverty. Benefits include lower fertility and infant mortality rates, better health and nutrition, higher productivity and chances that the next generation will in turn be educated. But shaking up bureaucratic, patriarchal structures might well be the most mammoth task of all. "Civil structures are often set up so that there is very limited incentive to invest in improvements and work towards goals and targets," says Winter. Some examples of good practice involve skirting slow bureaucracies and vested interests. In India, for example, the state of Uttar Pradesh took advantage of a law on developing charities to set up a well-staffed "parallel" structure to push through a comprehensive package on girls' education in rural areas. Women in the community walk girls to school, parent-teacher associations and principals reach out to homes where children aren't enrolled, and local groups stress to mothers that schooling is a basic legal right.

Such fine-tuned strategies can only bear fruit when countries are ready to take the first step, by addressing deeply set biases in their societies. Committed governments, say activists, can start changing the tide, from making education compulsory to delaying the age of marriage and opening their eyes to the realities of child labour. Otherwise, ten years down the road, millions of girls will still go missing from the classroom, keeping the wheel of poverty turning. ■

1. *Partnership for Strategic Resource Planning for Girls' Education in Africa, conducted under the auspices of FAWE, in collaboration with national governments and the Institute of Development Studies, Sussex (UK). Other partners include the Governments of Norway and Ireland, the Rockefeller Foundation and the World Bank.*

www.id21.org
An online education reporting service run by the Institute of Development Studies
www.unesco.org/education, to keep up on international initiatives
www.fawe.org
www.antislavery.org, for more information about child labour and how to fight against it
www.girlseducation.org, to find out about a new multi-agency partnership on girls' education

WHEN GIRLS GO MISSING

Community schools: Egypt's celebrity model

Two hundred schools in deprived hamlets of Upper Egypt are sending ripples through the country's education system, making girls and women the beacons of a new learning experience

© J. Tagher Roche/UNICEF

Plenty of fun keeps everyone's attention.

MALAK ZAALOUK

EDUCATION SECTION CHIEF, UNICEF CAIRO

When in 1992, community schools came to the *ezbah*—hamlets along the Nile that are islands amidst an arid desert landscape—they started from scratch, in places with no basic services. While some districts are notorious for their seclusion of girls and women, the overriding obstacle to schooling was distance and economic duress. "We wish all girls, women and men of the village would get an education," said an elderly man from Helba, a hamlet in the governate of Assiut,"but we cannot afford it,nor can we allow our girls to go to far places on their own."

In most rural areas of the south, girls' net enrolment rates range from 50 to 70 percent, compared with 90 percent nationally. In the most extreme cases, only 12 girls are enrolled for every 100 boys. Although the government tried to reach these groups in the 1970s through small multigrade schools, population growth, combined with economic strife and teachers' low qualifications, led to high absentee rates, and the initiative gradually disappeared.

From the outset, we were in this endeavour with communities and the Ministry of Education. Communities donate space, ensure that children come to class and manage the schools through an education committee in each hamlet. The Ministry pays facilitators and provides textbooks while UNICEF is responsible for the overall development of the programme.

Lifting the economic barriers was a first step: rooted in communities, the schools are close to the home. Timetables are flexible and all hidden costs are knocked out, from uniforms to schoolbags. But the other pivotal dimension is quality. Parents take it for granted that their sons will go to school. This is not the case with girls: you have to prove the experience is worth it.

Tapping creative talents

Our model relies on active learning. After intensive training, young facilitators—women chosen from the area with an intermediate school certificate—know how to transform the contents of the government curriculum into activities, such as cards, games, etc. They enhance it with subjects suited to local interest, such as health, environment, agriculture and local history, and encourage self-directed activities, learning by doing and in small groups.

A plethora of hand-made curricula has flourished over the years, which were on loan to the curriculum development centre for a year. The centre invited the facilitators to help produce learning guides in math and Arabic for grades one to three, which will be distributed to some 3,500 multigrade classroom schools in rural areas. These have been launched by the government, on the basis of the community school model.

Now we are designing teacher training in tandem with government and implementing it ourselves:in short,we are training a whole new corps of inspectors, supervisors, headmasters and teachers in this new "active learning" pedagogy. We are gradually negotiating with regular schools to assess children's achievement other than through regular exams.

If we are making headway, it is also because we have been fortunate to benefit from highly committed policymakers. From the outset, the initiative has not been regarded as a project, but as a contribution to national educational reform. Since 1995, an Education Innovations Committee has been systematically working to incorporate new pedagogies in mainstream schools. Beyond reaching the hard to reach, namely girls, this model is showing the way to changing the classroom experience for all.

Since the programme was launched, we have reached some 6,000 children, and female enrolment stands at 70 percent. The real barrier lies in girls continuing their education, even though evaluations show that our graduates pass government exams with flying colours. The first lady, a longtime defender of education,has given prizes to community school graduates, to the tune of nationwide media coverage. Within communities, the schools are catalysts for more profound changes: we are seeing facilitators publicly declare they will only marry a man who lets them continue teaching, and 12-year-olds convincing their parents to postpone marriage until they graduate. Slowly, girls are gaining a voice in areas far from the city walls. ■

SCIENCE A
The riddl

Contents

Four hundred years ago, Giordano Bruno suffered an unenviable fate: his tongue gagged, the Italian astronomer was burnt at the stake for maintaining, among other things, that each star in the sky is a sun like our own and space is infinite. Like it or not, modern science has proved him largely right. Our universe is of daunting size, mysterious origin and unfathomable purpose.

The frontiers of cosmology explored in this issue lie far beyond the human scale. Using the renowned big bang theory of creation (pp. 18-20;pp. 26-27), scientists have deployed telescopes, mathematics and particle collisions to plunder further through the first moments of time. Could an inconceivably fast expansion have ballooned the early universe (p. 21)? Might we inhabit a distorted strip of reality, unable either to observe the deep structure of matter (pp. 22-23) or discern the vast optical illusion that is in fact the universe (pp. 24-25)?

Yet while each new theory strives to fill a gap in our understanding, science may be nearing its own limits. The sheer improbability of life remains unexplained (pp. 28-29),while no cosmic theory seems free of deep metaphysical assumptions (pp. 30-31).Centuries after being displaced from the heavenly bodies, could God once again be the answer to our doubts (pp. 32-35)? Or is that just a get-out clause, to be replaced by a theory of multiple recycled universes not unlike those of Hindu myth (pp. 35-36)?

The consolations lie in awe of our ineffable and sublime origins. The cost may be in knowing (see the short story on p. 37) that all we leave behind is a very faint noise.

Dossier concept and co-ordination by Ivan Briscoe. Scientific advice from Jean-Pierre Luminet.

ND CREATION

e in the skies

OPINION

A PHOENIX OF **HUMAN NATURE**

BY SARA SCHECHNER

DAVID P. WHEATLAND CURATOR OF THE COLLECTION OF HISTORICAL SCIENTIFIC INSTRUMENTS, HARVARD UNIVERSITY

Since ancient times, people have marvelled at the night sky and sought answers to profound questions there. What are the heavenly bodies? What moves them? How do they affect one another? Where are they? And how do they affect us? These are questions of cosmology, and each age and culture has produced its own answers.

To the modern astronomer, acceptable answers come from physics. But if I may point my telescope not just towards deep space but also back in time, I would suggest that modern answers continue to draw upon deep-seated cultural values.

Religion, social practices and observational astronomy have long been intertwined in the development of cosmological beliefs. The ancient Egyptians observed the dawn risings of key stars and from them established not only their agricultural calendar and civil timekeeping, but also their religious rites. Two thousand years of observations gathered by Babylonian astronomer-priests gave rise to mathematical planetary astronomy, which Greek philosophers such as Aristotle used as the basis for their physical models of the cosmos. Aristotle's cosmos was structured, hierarchical, finite, and compatible with the tenets of Christianity, Judaism, and Islam. God was Prime Mover of the planets and the unmoved foundation of a stable world system.

In the 17th century, the Aristotelian cosmos gave way to the Newtonian world view. Looking out into an infinite universe, Isaac Newton showed how the motions of the stars, planets, and comets were all governed by universal gravitation. Comets circulated vital spirits and fuel to the stars, but could also slam into worlds, causing mass extinctions and global destruction.

In 1755, Immanuel Kant offered a physical theory on the origin and evolution of the universe. He described how universal forces of attraction and repulsion, acting on matter diffused throughout space, gave rise to instabilities in the chaos, leading to physical and chemical complexity. Denser regions gravitationally attracted lesser ones, while the action of repulsive forces caused in-falling matter to swirl around the dense centres. Over time, these vortices collapsed into stellar systems containing suns, planets, and comets.

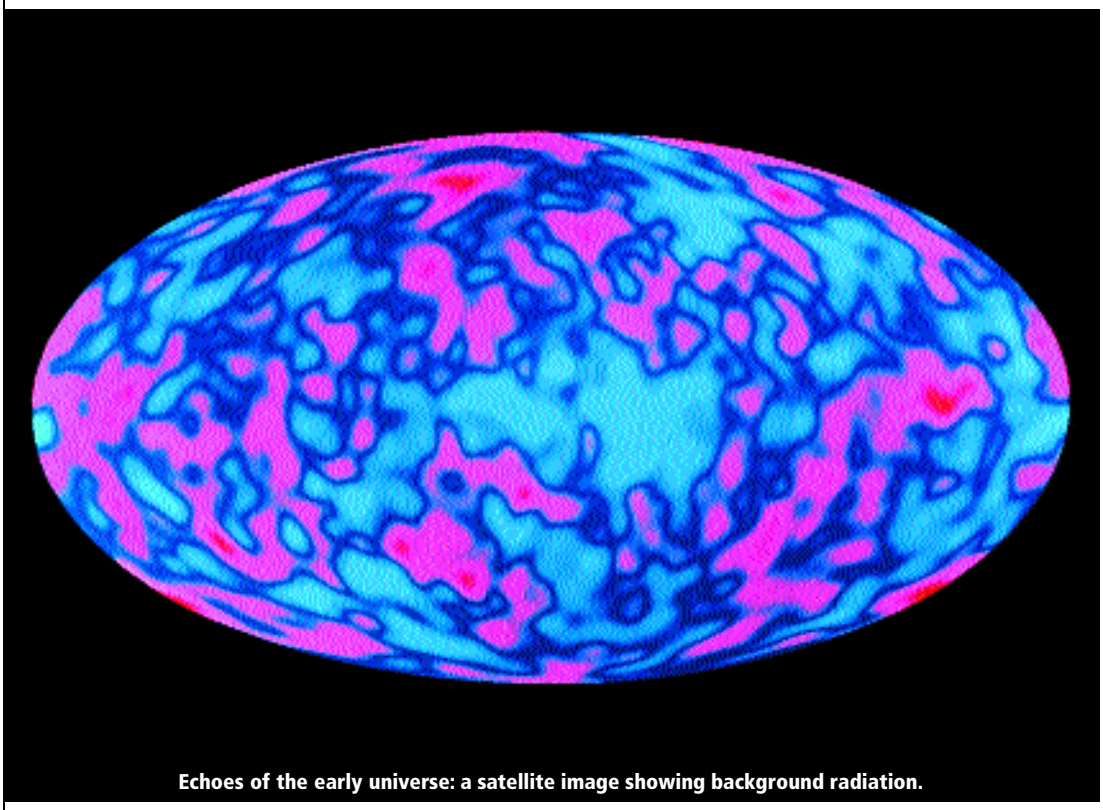
Creation thus spread out from a central point into the chaos and animated the whole region of infinite space. But Kant observed, "whatever has a beginning and origin, has the mark of its limited nature in itself; it must perish and have an end." When a world-system exhausted all the manifold variations that its structure could embrace, it perished in a violent conflagration. The universe was, Kant envisioned, a "phoenix of nature, which burns itself only in order to revive again in restored youth from its ashes, through all the infinity of times and spaces."

Kant's book was one of the earliest attempts to describe the origin and evolution of the cosmos under the influence of universal natural laws. Prior to Kant, it was commonly held that creation was fixed and the universe was maintained in a steady state. So where did Kant's modern evolutionary ideas come from? From popular culture as remade by Newton.

Until the 17th century, people believed that comets were divine signs heralding imminent world change. Newton appropriated this popular belief when he portrayed comets as natural agents deployed by God to create, renovate, or destroy heavenly bodies, thus melding popular beliefs with physics. This new approach gave license to those who held that material forces created new solar systems and the universe evolved according to natural laws.

If popular beliefs were formative in the early development of modern cosmology, should we be worried that they continue to sully current science? Not at all. We can still celebrate the ways our diverse cultural heritages have shaped our scientific inquiries. Cosmology is ultimately a human endeavour. In asking questions about the deep past and distant future, it draws from many rich traditions and brings us closer together as human beings. ■

1. SCIENCE AT THE LIMITS



Echoes of the early universe: a satellite image showing background radiation.

From **bang** to **eternity**

The big bang is now the accepted scientific account of how the universe came into being and started to evolve, but there is still much left to discover

GEORGE ELLIS

PROFESSOR OF APPLIED MATHEMATICS AT THE UNIVERSITY OF CAPE TOWN (SOUTH AFRICA), AUTHOR OF BEFORE THE BEGINNING (BOWERDEAN/MARION BOYAR, 1993)

Cosmology aims to determine the nature of the universe on the largest observable scales, and then explain how it got to be the way it now is. Dismissed for a long time as a largely philosophical enterprise based on a few sparse observations, this branch of science has undergone an extraordinary transformation in the last 50 years, becoming a compelling body of knowledge about the universe, rich in data and tied to the most pioneering advances in nuclear and particle physics.

On the one hand, the discipline relies on telescopes of all kinds and their associated measuring instruments and computers, amplifying and analyzing the incredibly faint radiation[1] from very distant matter. Observations of apparent size, radiation fluxes and numbers of distant galaxies and quasi-stellar objects can now be obtained up to almost inconceivable distances. When twinned with theories of physics—namely mathematical laws that characterize how matter and radiation behave—the result is something that few scientists a century ago would have believed possible: a "physical standard model" of cosmology, comprehensive enough to take us back to the first few seconds of the universe' existence, when atomic nuclei formed. Less defined and more speculative science promises to take us even further, possibly back to the very threshold of creation.

The basic structure of the visible universe on the largest scales is now well understood: there are vast domains of empty space more or less uniformly populated by clusters of galaxies, with each galaxy itself being a dynamic configuration of about 100 billion stars interspersed with dust and gas.

Furthermore, the fundamental motion of the cosmos is known: a uniform expansion of these clusters of galaxies, with distances between them ever-increasing equally in all directions. If we extrapolate backwards in time, this movement would suggest an ever higher density and temperature of matter and radiation, which at a certain point in the distant past—in conditions of the most extreme heat—coupled tightly together. Estimates of an origin to this expansion indicate it began around 10 billion years ago.

1. *Radiation is the flow of energy via subatomic particles. The term comprises radio waves, microwaves, infrared rays, visible light, X rays and gamma rays.*
2. *Light moves to the red side of the visible spectrum when its source is moving away. This phenomenon is called the redshift.*

At the extreme temperatures (over a billion degrees centigrade) of this initial phase, matter existed only as the most elementary particles in equilibrium with radiation. No more complex structures could survive the bombardment of the radiation at those temperatures. But as the universe expanded and cooled, successively larger and more complex units could form: first of all, within the very first second of the cosmos, protons and neutrons from quarks, thus far among the most fundamental units of matter yet known to exist. Then, only minutes after the universe began, these protons and neutrons could combine into light atomic nuclei, a process known as *nucleosythesis*.

Some 300,000 years later, complete atoms were constructed from nuclei and electrons—an episode called *recombination*. This event allowed the radiation, which had previously been trapped by the floating electrons, to separate (or *decouple*) from matter and flow freely for thousands of millions of light-years, cooling all the while due to the expansion of the universe from a temperature of about 3,000 degrees Kelvin at emission to 2.75 Kelvin (–270 degrees centigrade) today. This radiation, known as the cosmic microwave background radiation, provides the best map we now have of the very early universe.

As the universe expanded and cooled, successively larger and more complex units could form.

Once complete atoms were formed—mainly in the shape of hydrogen and helium—gravitation could pull matter together to form the first generation of stars, which clustered together to form galaxies, which in turn bunched together to form clusters of galaxies.

Some of the first generation stars ended their lives in massive supernova explosions, spreading through space the elements of organic life they had been forming in their interiors through successive nuclear reactions. The resulting clouds of dust then became the birthplace of second generation stars, surrounded by planets, on which the molecules of life could find hospitable places to generate the first living cells and so provide the origin of complex living beings (see also pp. 26-27).

There are three basic reasons for believing this picture of our universe's history. Firstly, estimates of the distances of galaxies (obtained for example from their luminosities) can be correlated with estimates of the speed at which they are moving away from us (deduced from their measured redshifts[2]). The data shows that the further away the galaxies are, the faster they are receding from us, thus providing basic evidence for the expansion of the universe. Secondly, the very existence of the cosmic background radiation is evidence that there was a hot early state of the universe, because its precise spectrum—exactly described by a theoretical formula deduced by Max Planck 100 years ago—shows that matter and radiation were in equilibrium at early times. Such equilibrium indicates that the early universe was very hot, for only at extreme high temperature can this balance come into being.

A third piece of evidence comes from observation of the abundance of light elements in the universe, namely hydrogen, helium and lithium. Our theory ▶

"The whole theory of the universe is directed unerringly to one single individual—namely to You"

Walt Whitman, American poet (1819-1862)

THE WAY AHEAD FOR COSMIC SCIENCE

What are the major issues that remain for us to tackle? First, we want to know more about the geometry of the universe, both inside and outside the limits we can observe. The part of the universe we can see seems to be remarkably simple on the largest scales, being spatially homogeneous and isotropic (it looks the same in all directions). But the major parameters describing this region are only loosely known. Uncertainty in our estimates of the universe's age is about 20 percent, and needs to be improved, as do our estimates of the dark energy that is causing an accelerated expansion of the universe. We also want to know if sections of space close up on themselves, and if so, whether the scale of closure is such that we live in a "small universe" where we see multiple mirror images of the same galaxies (see pp. 24-25).

Second, we want to know more about what the universe is made of. It is disappointing that we don't know what kind of matter makes up the lion's share of the density of the universe, nor the nature of the force that presently dominates its expansion. Better understanding of these features is intimately tied in to a better understanding of the creation of large-scale structure in the universe.

Third, we want to understand the very early universe better: in particular, what caused the mighty cosmic inflation? What came before inflation? What was the nature of creation, and what alternatives are there to creation?

Though there are a wide variety of competing proposals, it proves very difficult to test them experimentally. To help resolve these, we need to extend our understanding of particle physics as far as we can so as to probe the interactions at work at the moment of creation and immediately thereafter. However far we extend experiments probing this physics, we will nevertheless be unable to attain the energies required to unlock experimentally the secrets of quantum gravity.

There are thus clear limits to the testable laws of physics that underlie the cosmological account of creation. The challenge is to develop a coherent and convincing physical theory that is supported by tests insofar as they are possible.

Fourth, we must grapple with the question of how to relate theory to observation in the exceptional context of a science with only one object of study—the single existing Universe. We lack a proper account of the limits of scientific proof in this context. One attempt to break this impasse is through the idea of an ensemble of universes (a "multiverse"), but it is not clear yet if this is a physical or a metaphysical proposal. ■

of how atomic nuclei were formed in the hot early universe, based on knowledge of nuclear physics together with the hypothesis of an expanding universe, fits all these measurements just so long as the density of matter lies in a specific limited range—a remarkable confirmation of theory by observation.

As a result, this cosmological history has come to be accepted by the scientific community. We have clear evidence that the universe emerged at vast speed from an initial fireball, though this event's remoteness—and the enormity of space—obviously leaves a host of questions waiting to be answered, particularly as we try to understand its origins.

Recent observations have nevertheless filled in many details of the universe's structure and history. We have been able to obtain estimates of the amount of matter in the universe, particularly from studies of the motions of galaxies and clusters of galaxies. On the basis of these figures, we have been able to deduce the presence of a large amount of mysterious "dark matter"—matter which can't be detected by emitted radiation such as light because it is simply not shining. By comparing these estimates of the amount of dark matter (about 95 percent of the universe's mass) with those coming from the nucleosynthesis calculations mentioned above, we can deduce that most of this matter is not composed of protons and neutrons: in short, that it has an entirely different make-up to that of ordinary matter.

We expected the expansion of the universe to be slowing down because of gravity, but in fact it seems to be accelerating.

We have also been able to get much better distance estimates than before for faraway galaxies, particularly by observing supernovae explosions in them and measuring the decaying light from these death throes of burnt-out stars. This has led to another unexpected discovery. We expected the expansion of the universe to be slowing down because of the gravitational pull of all matter, but in fact it seems to be accelerating. This must be attributed to some form of dark energy which, unlike the dark matter referred to above, acts like a negative gravitational field, tending to make all matter move ever faster apart. Consequently, it now seems clear that the universe will expand forever.

Theories of how galaxies and galaxy clusters arose have also been subject to intensive research. By connecting data on the gravitational effects and distribution of galaxies with minute temperature fluctuations across the sky in the cosmic background radiation, we have been able to construct broad pictures of how large-scale structures emerged from small variations in density in the early universe.

Yet these findings leave a major question begging: how can we possibly explain why the universe is so homogeneous (i.e. uniform) in all directions while also hosting from very early on in its existence minute differences in density that served as the seeds of future galaxies?

The remarkable concept of inflation—a period of extremely rapid accelerating expansion in the very first fraction of a second of the universe's life—potentially explains both features. Such an enormous expansion might first have smoothed out space, before quantum fluctuations[3] in this early force created areas of marginally different densities. Expansion, first inflationary and then decelerating, may then have spread such tiny variations over regions the size of galaxy clusters. From these beginnings, matter could then be pulled by gravity over billions of years into the stars and galaxies we are now so familiar with.

Finally, some current studies of distant spectra give tantalizing hints that the nature of physics itself may be different at great distances, in places whose radiation emissions we are receiving billions of years after they were emitted. Might it be that the constants of nature vary with time? If so, this would be a discovery of groundbreaking significance.

The next few years and decades are certain to see a massive extension in the quantity and quality of cosmic observations. These will be accompanied by enriched theories of how matter clustered to form galaxies and a deeper exploration of gravity, both of which will help determine the model that best fits our observable region of the universe.

But even once this model is drawn, a host of elusive issues await. How should we link what we understand of quantum gravity[4] to cosmological theory—especially the creation of the universe? What of the possibility that the laws of nature were different in the early universe? And how common is life in the universe? Could one in any other way create a universe allowing intelligent life to exist?

This sets the framework for considering major philosophical issues within the context of the uniqueness of the universe. Science *per se* can never resolve these issues, but it can at least provide an ever

3. *According to quantum mechanics—the science of energy and particles at subatomic levels—energy waves will tend to fluctuate randomly.*
4. *Quantum gravity is the as yet unknown theory of how gravity works at the quantum level. The theory is believed to have held at the moment of the universe' creation.*

A HUNDRED YEARS OF PIONEERS

1905: Albert Einstein announces the theory of relativity.
1912: Ernest Rutherford discovers the atomic nucleus.
1924: The basic equations for quantum mechanics are established.
1929: Edwin Hubble reveals that the universe is expanding.
1950: The term "Big Bang" is coined by astronomer Fred Hoyle. It is meant as a put-down, but it sticks.
1965: Cosmic microwave background radiation is discovered.
1981: Alan Guth presents the first version of the theory of cosmic inflation.
2000: First possible experimental evidence of Higgs Field—the force that gives mass to particles.

1. SCIENCE AT THE LIMITS

And then there was **inflation**

The hottest theory of cosmology in the last 20 years is that of cosmic "inflation"—a burst of force in the very early universe that expanded a dot into almost boundless space. Professor Andrei Linde of Stanford University, one of the theory's chief exponents, explains

INTERVIEW BY IVAN BRISCOE

UNESCO COURIER JOURNALIST

Why do we need a period of inflation in the universe's early history?

Inflation explains several different things: why the universe is large, why it is homogeneous, why it looks approximately the same in all directions, why it started expanding simultaneously. It also explains how galaxies have been formed out of quantum fluctuations.

Above all, we need to explain why different parts of the universe look approximately the same. Imagine that the universe just started. At the very earliest time we can consider [10^{-43} seconds after creation, called the Planck time], our universe was a fraction of a centimetre. In this time, light and radiation could only have travelled a tiny part of this space. So the left side of the universe could not know about the right, and the middle about neither of them: there was no time for such contact. Then all of a sudden we have a universe where everything is exactly the same. This looks like a miracle—something physicists do not expect.

This is where inflation comes to the rescue. In the simplest version of the theory, inflation starts at the Planck time. Until 10^{-35} seconds, space would blow up by the power of 10 to the thousand billion, rather like an elastic membrane stretching in all possible directions at a speed faster than light to a size much larger than the universe you now see. Our universe would then be a tiny spot on a huge cosmic balloon.

Is there any matter inside this expanding space?

Usually people understand by matter particles that move, collide and build solid things that we can see. But there are also fields—electromagnetic fields for example. We do not see the magnetic field of the Earth, but we know that it is there. This field is also a kind of matter.

Our assumption is that in the early universe, matter was in a very specific form called a scalar field. We do not see this field—it looks like a vacuum—but if it exists it may have a lot of energy. In a normal expanding universe the density of matter decreases, but the scalar field and its energy do not decrease, meaning space expands faster and for a much longer time. This leads to inflation.

Gradually, however, the scalar field loses energy. It decays and produces normal particles, and the universe becomes hot as in conventional big bang theory.

But where did these scalar fields come from?

They could exist in the universe from the very beginning, just like any other matter. Those parts of the universe where these fields were small did not experience inflation and therefore remained very small. But regions of the universe with large scalar fields have grown up enormously. We live in one such region now.

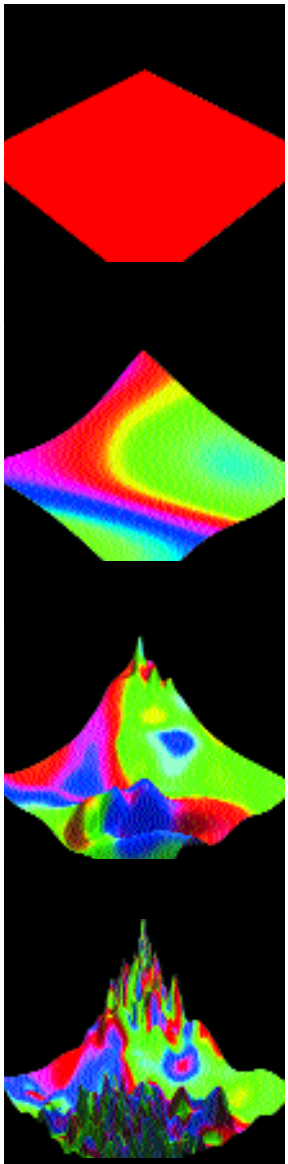
You have used the expression "cosmic tree" to describe the true universe. What does this mean?

Small fluctuations in the field are necessary for the later formation of galaxies. But if the fluctuations in this field are large, they could lead to the creation of new parts of the universe—not just galaxies, but places where the fields have different values, particles are lighter or heavier, and space and time different as compared to our part of the universe. These are so far away from us, however, that you will never have a chance of seeing them.

You also call this inflation eternal. Does this mean it can happen again?

It may happen at some distance from us now. It might also happen here, though you are not going to see it because inflation occurs when space is expanding from its own resources. If inflation happens near you, don't worry—it's not going to crush you. It's just going to create a baby universe that you will not see.

Twenty years ago, when inflation was invented, it looked like a piece of science fiction. Gradually it has become the standard cosmological theory, solving many problems and making important predictions that can be experimentally confirmed. We've tried hard doing something without inflation, but so far nothing else has worked. ■



Quantum fluctuations in an inflationary universe sometimes create regions with very large density (the peaks) and divide the universe into regions with different laws of physics (shown by different colours). We live in a low-density region. High density regions expand extremely fast and produce more areas of even higher density. This starts an eternal chain reaction of self-reproducing universes.

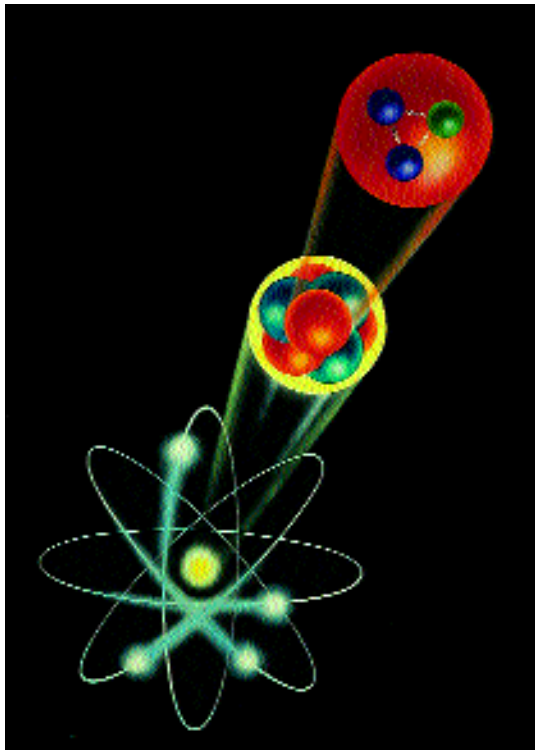
1. SCIENCE AT THE LIMITS

What came **before**

Do the secrets of the universe lie within the atom? Could a 27-kilometre tunnel reveal the deep truth?

IVAN BRISCOE

UNESCO COURIER JOURNALIST



Inside the atom (left) lies the nucleus;inside the nucleus, neutrons and protons; inside each of them (top right), three quarks.The search for elemetary matter continues.

Reverse the film of our universe's history, and things seems to get mighty strange in the last reel. What began in physical harmony, propitious for planets, humans and domestic appliances, has reverted to hell: temperatures hotter than the sun's core, an exotica of hysterical matter, forces rupturing asunder. Nudge the reel a bit further on, and the image abruptly switches from fury to a vague and peaceful nothing.

It is not an ending—or rather a beginning—that satisfies too many people. Though little headway has been made exploring this peculiar transformation of nothing into hot and very excited everything, the issue has not been absent from scientific minds. If only to combat the allure of a "God particle" bent on generating the cosmos, science has searched for an alternative:not just a history of before the big bang, but some deeper reason for why, out of unfathomably chaotic stuff, should emerge a place where a hair-dryer works.

Gabriele Veneziano is one of those who believes an answer may have been found.According to this leading Italian theoretical physicist,a deeper reality lies "under"the one we perceive. Superstrings, to be precise, vibrating away in 10 or 11 dimensions, creating and composing the entire universe from their minuscule shudders.

Deciphering his account of how the universe came to be reads like an odyssey through 20th century physics. Superstring theory, and its many cousins in the domain of elementary particle physics, are offshoots of the two great theoretical inventions of the century's first decades—general relativity and quantum mechanics. On the basis of the first, a convincing picture of the universe could be drawn back to an initial point, or "singularity," of massive, possibly infinite density. Through the quantum world, vast leaps could be made in penetrating the atom, the components of the atom (protons, neutrons and electrons),and then,colossal equipment and minds permitting, the components of the components of the atom.

Slam and see

At that point, the two theoretical roots join as one. Assuming the universe is created in a blazing, primordial soup, then clearly the most basic units of matter will be those that prevail. Finding out what rules govern them is then the golden bridge towards understanding how the universe was made.

Until the end of last year, a palm-sized pipe wrapped in potent magnets and circling beneath the Franco-Swiss border was the world capital for such investigations. Along this 27-kilometre pipe, a pair of electrons would pass 11,000 times a second—close to the speed of light—before hurtling to a splintering collision. Such is CERN, the European laboratory for nuclear research. The principle is simple: slam and see.

Behind the principle lies a very basic formula, Einstein's $E=mc^2$, which establishes an equivalence between energy and mass. Accelerate a subatomic particle like an electron or proton, crash it into a partner, and the energies accumulated in its light-speed dash will be scattered into more massive, very short-lived particles—exactly the sort of particles that reigned in the early universe before gluing together as space cooled.

The appetite of scientists has naturally not abated.

1. *Another target for research might also usher in a new unity. This branch of theory, known as supersymmetry, speculates that a fundamental balance exists throughout the quantum realm,and that at high energies the "superpartners" of known particles will flit into*

By 2005,a new accelerator is due to be operating at CERN: the Large Hadron Collider, armed with a magnetic field 100,000 times that of the earth, interspersed with six-storey high detectors and able to take subatomic conditions back to those which held in the universe's first picosecond (10^{-12} seconds). "We are going to be able to probe distances inside matter which are perhaps ten times smaller than we've seen before," explains John Ellis, a senior physicist at the laboratory.

Through theoretical work and experiments at this and other accelerators, scientists have already disaggregated the atom and the forces that rule its movements into a menagerie of over 60 particles. A story of the universe has emerged:a tale of descent from high to low energy, in which primitive forces split (creating electricity), and unstable fundaments of matter convert their mass into the astonishing energies inhabiting every atom.

The staircase of universes

But the story is far from complete. It may be very well to enumerate and calculate the powers of quarks and spins of photons, yet how could such an encyclopaedic set of characteristics sprout so level-headedly from a meltdown? Perhaps more importantly, where does gravity fit in? Its supposed force-carrier, the graviton, has never been observed. The force itself appears alien to quantum theory. And its strength for each atom is derisory compared to the belligerence of the nuclear and electromagnetic forces:how else could a chair buttress you from the entire gravitational attraction of the planet?

In search of an answer, the scientific community has appealed to the notion of unification. The deeper one gets into the interstices of matter, they argue, the more sweeping and elegant the formulae may become.

The lust for a unified theory behind nature has prime targets in sight. In a last gasp of CERN's old accelerator, the first experimental indications emerged of the so-called Higgs field,an arena of force like the electromagnetic field with which species of particles interact (or do not) and win their very unique masses. "Imagine you're cooking pasta," says Ellis, "and you add olive oil. When it cools, the olive oil separates out. What we're trying to do in the new collider is boil the water so that we can see the differences evaporate."[1]

Yet this still leaves the gravitational conundrum unresolved. John March Russell,a physicist at CERN, enthuses over one mind-bending possibility: that gravity is so weak in comparison to other forces because much of it is swallowed into other dimensions. Should this be the case, he says, the new collider may reveal more than just new particles:energy might be sucked away into the nether-world, or even more radically, tiny black holes may form for a fraction of a second.

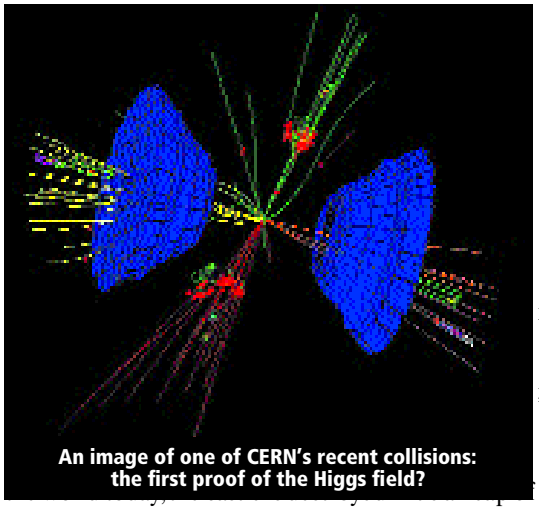
Such extra dimensions would appear to make elementary particles that bit more baffling, but the opposite is probably true:it may offer the first proof that strings exist. "Theoretically, the gravity problem and string theory fit together very nicely," argues March Russell.

But what precisely are these magical strings? For around 30 years, theorists have laboured over rival sets of formulae explaining how string-like phenomena, around 10^{-32} cm in length and thus invisible to all possible experiments, generate the entirety of known particles and forces, including gravity. If true, it would be the deepest theory ever encountered: the overarching law breathing form and function into the universe.

Unfortunately, their infinitesimal size and supplementary dimensions have given the theory an air of high abstraction, but Veneziano, also of CERN, is undaunted. For him,the epoch of creation might have to be rewritten. "I see the big bang as a way to put string theory to the test. When you get very close to time zero, strings simply cannot fit into space."

The results are revolutionary. No infinitely dense singularity could exist at the start of the universe because of the strings' irreducible size. Instead, a "pre-history" must be sketched in. "This could be a very long pre-history starting with an almost trivial, infinite universe filled with gravitational waves that barely interact at all," says Veneziano. "The beginning of the process ending in the big bang is the occurrence of an overdense region leading to the formation of a black hole." Within this hole, trapped waves start to interact in the form of strings. An early relative of gravity causes a lightning expansion of space, and at some critical and obscure moment,the era of strings cedes to the big bang, thus begetting the era of particles, planets and us. "What we have for most of the time before and after the big bang is a classical evolution," he says.

Major problems remain,above all in explaining why the underlying strings (or any other fundamental theory for that matter) do not lead to an utterly different set of physical laws. But the thought is still a giddy one—that reality migrates along a staircase of universes, each step recumbent on the one before. "In



An image of one of CERN's recent collisions: the first proof of the Higgs field?

"By convention there is colour, by convention sweetness, by convention bitterness, but in reality there are atoms and space"

Democritus, Greek philosopher (c.460-c.400 BC)

1. SCIENCE AT THE LIMITS

Mirror, mirror up above

Could we be living deep in a cosmic mirage, where rays of light multiply and distort our perceptions of space? Instead of being flat and infinite, might space not in fact be folded up—and our sense of the universe's vastness just an illusion?

JEAN-PIERRE LUMINET

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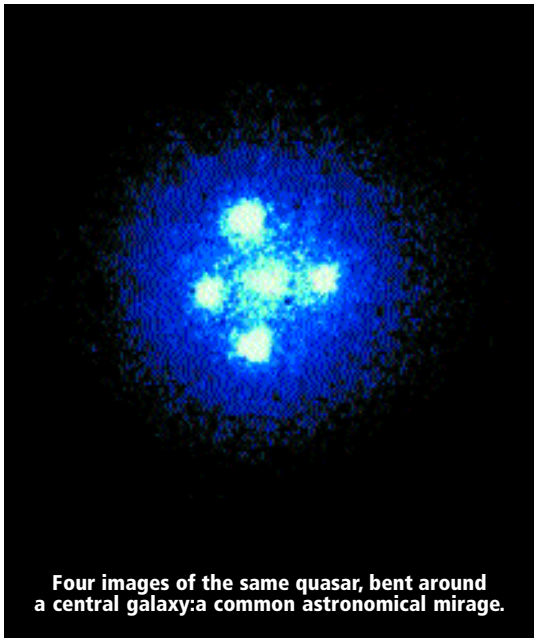
It is extremely difficult for most of us to give a shape to something as intangible as space. For the physicist, the question only has meaning if couched in the language of geometry. So then the question becomes: how can geometry best represent physical space—the space we inhabit?

The problem is much more complex than it first appears. There is no doubt that the space we live in and which we are familiar with is correctly described by what is known as Euclidean geometry, a set of laws devised by the Greek geometer Euclid in the third century BC.[1] But space at the tiny microscopic level, according to quantum mechanics, is a chaotic, fluctuating domain somewhat like the foam on the surface of an ocean, while at the very large cosmological level we learn that space is in truth "curved." When we ask what shape or form space has, therefore, modern physics actually gives us a variety of answers depending on the level at which we are looking.



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Four images of the same quasar, bent around a central galaxy:a common astronomical mirage.

Yet what exactly do we mean when we say that space is "curved"? The modern science of cosmology stems largely from the equations of general relativity formulated by Albert Einstein in the first two decades of the 20th century. According to these equations, all space is deformed, or rather curved, by the distribution of matter such as galaxies inside it. This curvature manifests itself as one of the universe's most fundamental forces: gravity.

Now if we turn to the universe as a whole—by which we mean huge scales of over 10^{25} metres—it appears that the virtually uniform distribution of galaxies throughout the cosmos must curve space in a likewise uniform fashion. Aside from this constant curvature, the universe should also have an underlying dynamic: in other words, it can either be expanding or contracting.

On the basis of Einstein's equations, Alexander Friedmann and Georges Lemaître discovered in the 1920s a set of models for such curved space. The most simple version points to so-called positive curvature, resembling a simple sphere that dilates from the big bang onwards to reach a maximum size before contracting back into a final "big crunch." Space could also have no curvature or a negative curvature (forming a "hyperbolic" shape that resembles a saddle). In both of these cases, the universe expands forever, though the rate of expansion slows over time.

Recent observations have suggested that cosmic space is in fact close to the "no curvature" model—in other words it is flat and almost Euclidean, like our normal understanding of space. But the data also indicates that the universe is expanding at an increasing rate, suggesting that some kind of "cosmological constant" is accelerating the expansion rate. This constant may be understood as the energy of empty space.

But important questions remain. Can general relativity really give us a satisfactory description of the shape of space at the largest scales? It is, after all,

1. *Based on five axioms (including his most famous one, namely that parallel lines do not meet), Euclid's 13-volume text* Elements *includes commonsense geometric theorems such as that the angles in a triangle add to 180º. Non-Euclidean geometry was created in the 19th century.*

still unclear whether space is finite or infinite: a spherical universe would certainly be finite, but a Euclidean or negatively curved universe could be either finite or infinite.

At this stage we need a new approach: that of topology, a branch of geometry devoted to exploring the properties that define particular spatial objects. Where the science of curvature falls shorts, topology can step in to tell us about the overall structure of space.

Euclidean space can certainly be a lot more complicated than imagined. A surface with no curvature, for example, is not necessarily flat. All one has to do to prove this is take a rectangular piece of paper and stick it together at the edges to make a cylinder. Just as with the original flat piece of paper, the surface of the cylinder is still Euclidean. The cylinder's surface thus still has no curvature, but unlike the flat paper, it is finite in one direction. This is the sort of property that topology, not curvature, can reveal. Cutting and sticking the flat piece of paper into various new shapes does not alter the curvature of the paper itself, but radically changes it overall shape—its topology.

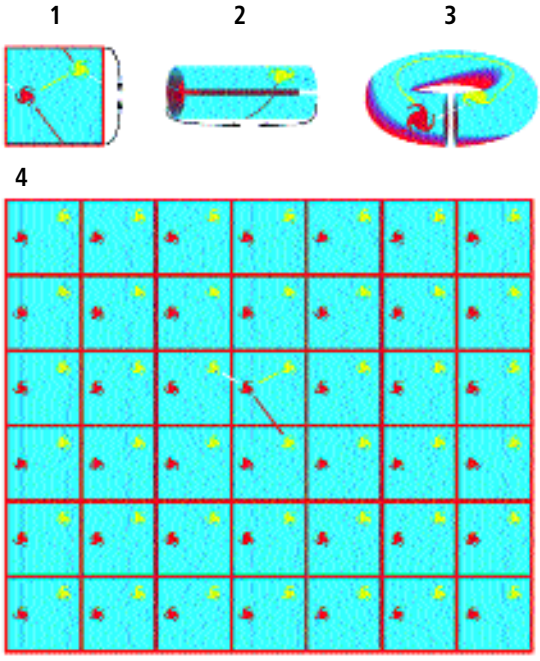
The dawn of ruffled space

In space which is flat, any two points can be joined only by a single line, or *geodesic*—meaning simply a line in curved space. In what we call multi-connected space, on the other hand, an infinite number of geodesics join two points together, as can be seen in the diagram. It is this very property which gives such spaces extraordinary cosmological relevance.

When we look at a faraway galaxy, we normally think that we are seeing just one unique object, in one particular direction and at one distance. But if cosmic space is multi-connected, rays of lights will replicate to produce multiple images of the observed galaxy. Since our entire perception of space comes from analysis of the trajectories of light rays, such a multi-connected space would mean we are plunged in a massive optical illusion that makes the universe appear much larger than it really is. Distant galaxies that we believe to be "original" would in fact be repeated images of a single galaxy.

A "ruffled" space would be just such a cosmos: a multi-connected domain of finite volume, whose size would be smaller than the observed universe (whose radius is around 15 billion light-years). This space would create a *topological mirage* that constantly repeated the images from shining sources—akin to standing in a hall of mirrors.

Similar optical illusions are already well known by astronomers, and go under the name *gravitational mirages*. These occur when light from a distant object such as a quasar is bent by the effect of a massive body situated on its sightline. As a result, light rays from the star follow the curvature of space and are scattered (see photo). What the observer sees is a group of phantom images surrounding the intervening heavy object (known by astronomers as a "lentil"). This sort of mirage can be directly ascribed to the *local* curvature of space around the lentil.



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A very simple two-dimensional universe illustrates how an observer in galaxy A (red) can see multiple images of galaxy B (yellow). This model of the universe, called a tore **(a doughnut shape), is constructed from a square stuck together on two sides. Instead of one line linking the galaxies, light from galaxy B can now reach galaxy A by various routes; as a result, the observer in galaxy A sees images of galaxy B from various directions. Though the** tore **is finite, the observer is under the illusion that space is much larger than it really it—his or her image of space is similar to a grid of repeated cells.**

In the event of a topological mirage, however, there is no single heavy body like a galaxy deforming space. Instead, space itself plays the role of a lentil: phantom images are distributed in all directions and for all their points in history across the entirety of space. Such a global mirage allows us to examine objects not only from every possible angle, but also from every possible phase in their evolution.

For space to have this ruffled shape, it would have to be highly subtle and constructed over very large scales. If not, we would have already identified phantom images of our own galaxy and other well-known structures—a feat we have not yet achieved.

So how can we then establish the true topology of the universe? One method, cosmic crystallography, attempts to pinpoint repetitions in the distribution of distant objects. Studies of fluctuations in the cosmic background radiation—a fossil from the big bang—might also indicate that space is ruffled by uncovering specific recurrences.

Experimental projects in both fields are underway, though neither the depth nor the resolution of observations are yet good enough to draw conclusions about space's overall topology. The next few years, however, promise great things: deep surveys of distant galaxies and quasars, along with new satellites probing background radiation. Perhaps we will soon be able to give a form to space. ■

The story of everything

❷ Space and time as defined by Einstein's basic laws of physics have as yet no meaning.

10^{-43} seconds (i.e. 0.00000000000000000000000000000000000000000001 seconds)

❹ "Inflation" has stopped. The primitive force which drives it leaves behind a series of elementary particles—electrons, quarks, gluons and neutrinos—existing in an environment of inconceivably high temperatures (10^{27} degrees centigrade). Exhausted, the universal early force breaks up into gravity and other forces operating at the nuclear level. Einstein's laws now apply. The universe continues to expand and cool.

10^{-35} to 10^{-12} seconds

❻ Quarks begin to stick to one another in threes, forming the first protons and neutrons—the building blocks of atoms. Anti-matter and matter meet and engage in mutual destruction, leaving for some unspecified reason a remainder of pure matter. The universe has chilled to a billion degrees centigrade.

10^{-6} seconds

❽ No light has been able to pass through the early universe due to its soup-like mixture of electrons and photons (carriers of light and other energy waves). Upon reaching 3,000 degrees centigrade, the electrons are finally able to cling to the basic atomic nuclei: the photons are thus set free, making up the universe's first ever electromagnetic signal. We can still hear its remnants today. Space is now transparent.

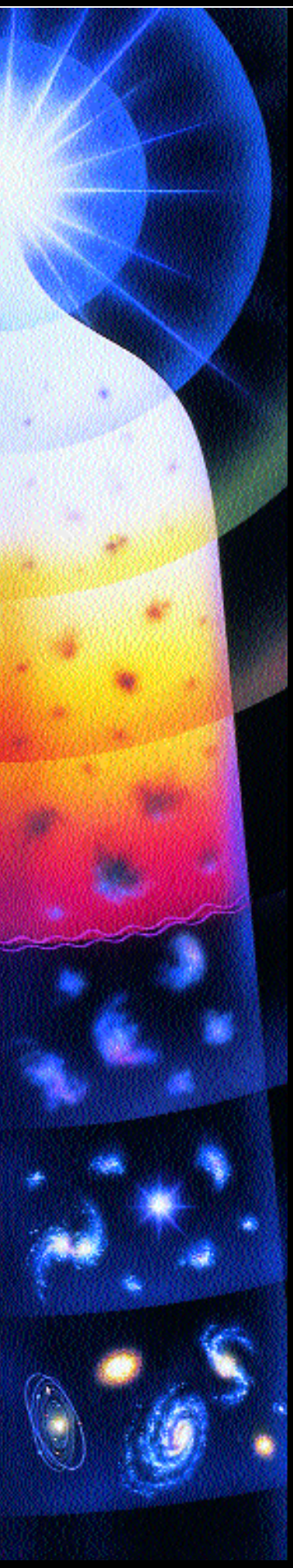
300,000 years

❿ Our Sun is formed along with the planets of the solar system, possibly due to a cataclysmic supernova blast followed by the gradual accumulation into spherical bodies of dust, rock and gas. On those planets closest to the sun—Mercury, Venus, Earth and Mars—most light gas is burnt off, leaving in the case of Earth a mix composed largely of iron, nickel, carbon, oxygen and magnesium. Distant planets, such as Jupiter and Saturn, remain gigantic globes of light gas.

Between 5.5 and 10.5 billion years (precise date unknown)

⓬ Multi-cellular organisms flourish, aided by the onset of sexual reproduction. The first vertebrates emerge in the Ordovician era. Plants, dinosaurs, reptiles, and mammals follow. Some five million years ago, various species of hominids begin to inhabit Africa. Homo sapiens steps forth over 100,000 years ago. Language, culture and human society are created.

10 (to 15) billion years



Time

0

1 The universe is born in unknown, possibly unknowable circumstances. Traditional Big Bang science suggested it emerged from a "singularity"—a point of infinite density at which all known laws of space and time break down. Speculation, however, has not abated: options for the first cause include a fluctuation in a field of quantum "foam," a growth inside a Black Hole or the bounce from a self-annihilating parent universe. Theists prefer the hand of God.

10^{-43} to 10^{-35} seconds

3 Current theories point to an era of rapid "inflation"—an expansion so fast that it outstripped the speed of light. From a tiny ball less than a millimetre in size, the universe may have ballooned far beyond the distances our most advanced telescopes can currently observe. The force behind this expansion is unknown.

10^{-11} seconds

5 The temperature drops to a million billion degrees centigrade. Electromagnetism is born. All four fundamental forces of physics—gravity, the strong nuclear force, the weak nuclear force and electromagnetism—are now in place. Time is ripe for the creation of more complex particles.

100 seconds

7 Neutrons and protons combine to form the most basic atomic nuclei—those of hydrogen, helium and lithium. The universe cools at extraordinary speed, so fast that there is no longer enough heat to form other, heavier elements.

2 or 3 billion years

9 The cosmic dark age ends with the formation of the universe's first ever stars at the heart of dense gas clouds. Compacted by gravity, hydrogen in these stars fuses into helium, pouring heat and light into space. Hot and violent nuclear reactions clamber up the ladder of the elements. Carbon, oxygen and magnesium are formed. Giant stars—called supernovae—expire in tremendous explosions, ejecting heavy matter across the evolving galaxies.

6.2 (to 11.2) billion years

11 Emergence of life. The very first cells begin to populate the earth. Early theories suggested the fundamental components for life, such as amino acids, were generated by the action of lightning on a primal stew of water, methane and hydrogen. Contemporary accounts postulate that asteroids impacting on Earth may have instead carried the seeds of organic life.

2. COSMOS, GOD AND US

Life against the **odds**

Cosmology has led us back to the very first second of the universe's existence, yet the more science reveals, the more it leaves unanswered

JOHN HORGAN

U.S. AUTHOR OF THE END OF SCIENCE (1996) AND THE UNDISCOVERED MIND (1999).HIS NEXT BOOK, THE DEEP END: GETTING TO THE BOTTOM OF MYSTICISM, WILL BE PUBLISHED NEXT YEAR.

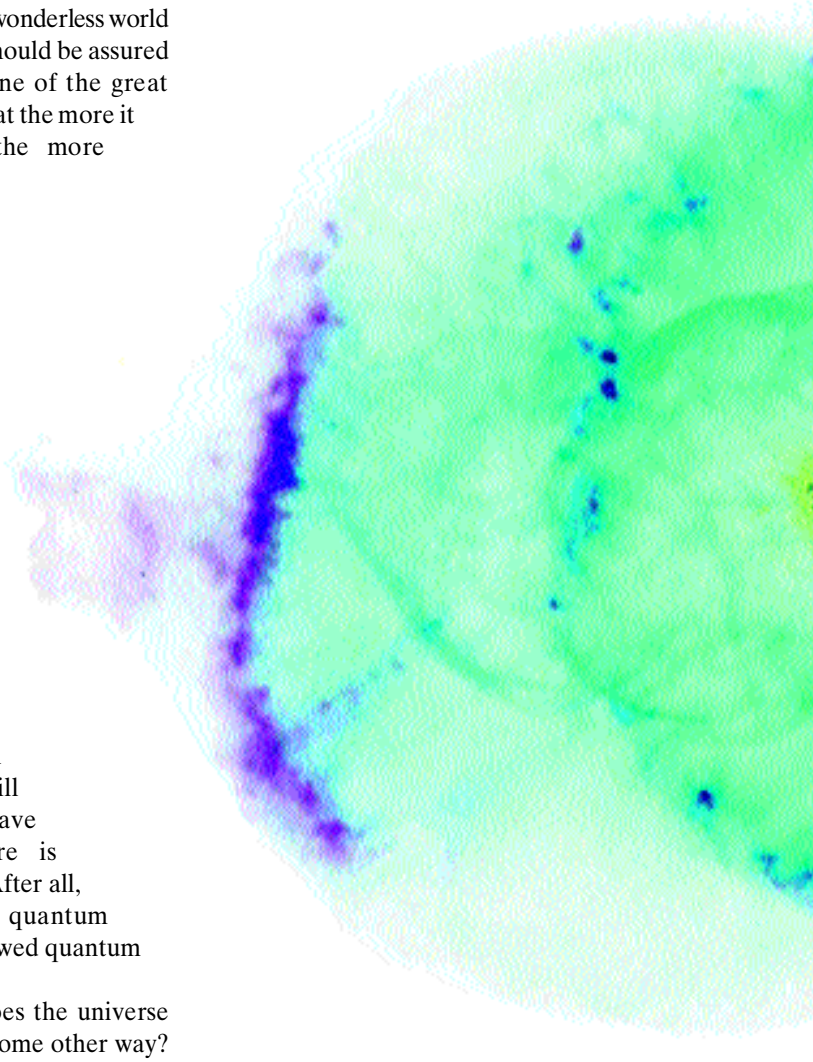
Is science on the verge of explaining the mystery of existence, once and for all? Some prominent scientists are suggesting as much. They claim that unified theories of physics such as superstring theory, when combined with refined versions of the big bang model, will soon bequeath us a so-called "theory of everything." As described by physicists such as Stephen Hawking, a theory of everything will be a kind of mystical revelation, which permanently transforms the "Huh?" of wonder evoked in us by our contemplation of nature into a great "Aha!"

Those who find this vision of a wonderless world chilling rather than exhilarating should be assured that it will never be fulfilled. One of the great paradoxes of modern science is that the more it tells about about existence, the more mysterious existence becomes.

The conundrum of reality

Take the simplest question of all: Why is there something rather than nothing? The big bang theory, for all its power, cannot tell us why and how the big bang happened in the first place. Some physicists note that according to quantum mechanics, empty space is seething with so-called virtual particles, which spring into existence for an instant before vanishing; perhaps, these physicists speculate, the entire universe began as a kind of virtual particle. Honest physicists will nevertheless admit that they have absolutely no idea why there is something rather than nothing. After all, what produced the laws of quantum mechanics, which supposedly allowed quantum creation to occur?

The next question is: Why does the universe look the way it does rather than some other way? Why does it adhere to these laws of nature rather than some other laws? Altering any of those laws would have radically altered reality. If gravity had been infinitesimally stronger, the universe would have stopped expanding almost immediately after the big bang and collapsed into a black hole;a bit weaker, and the universe would have flown apart so rapidly that stars, galaxies and planets would never have formed. The physicist Lawrence Krauss compares the odds against gravity having precisely the value necessary for the

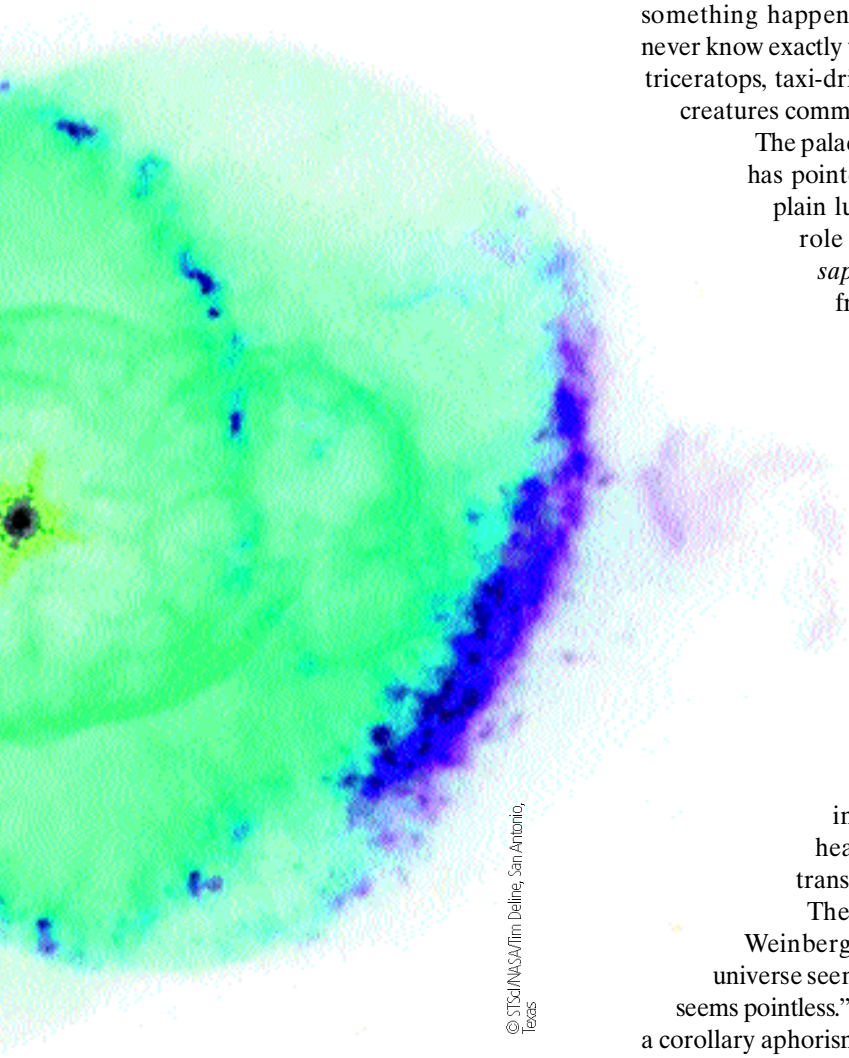


A negative image of the Cat's

cosmos to exist to the odds against someone guessing precisely how many atoms are in the sun.

Then there is the enigma of life. The biologist Richard Dawkins once declared that life "is a mystery no longer"because it had been solved by Darwin's theory of evolution by natural selection. Actually, life is still a complete conundrum, in spite of all the insights provided by evolutionary theory and more modern biological paradigms, such as genetics and molecular biology. None of these fields can tell us why life appeared on earth in the first place, and whether it was a probable event or a once-in-eternity fluke.

Dawkins and others proclaim that life is a robust phenomenon that occurs throughout the universe, but there is no scientific evidence to support this belief. After decades of searching, we have found no signs of life elsewhere in the universe. As far as we know, life emerged here on earth only once, approximately 3.5 billion years ago. Moreover, attempts to replicate the origin of life in the laboratory have left researchers more baffled than ever at how it occurred. The Nobel prize winner Francis Crick once complained that "the origin of life appears to be almost a miracle, so many are the conditions which would have to be satisfied to get it going." Crick, it should be noted, is an agnostic leaning toward atheism.



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Eye nebula,3,000 light-years away

Scanning the heavens for signals

Many scientists have contended that once life started evolving on the earth, it was only a matter of time before it produced a species as complex as we are. But the history of life on earth does not support such a view. For roughly 80 percent of life's 3.5-billion-year span, it consisted entirely of single-celled organisms, such as bacteria and algae. Then something happened—biologists will probably never know exactly what—and the era of trilobites, triceratops, taxi-drivers and other multi-cellular creatures commenced.

The palaeontologist Stephen Jay Gould has pointed out that contingency—just plain luck—has played an enormous role in the emergence of *Homo sapiens*. If life on earth started from scratch a million times over, Gould contends, chances are it would never again produce mammals, let alone anything resembling *Homo sapiens*. Similarly, the biologist Ernst Mayr suspects that we may be the only life forms in the galaxy and possibly the entire universe capable of inventing radios and other communications technologies. For that reason, Mayr believes that SETI—the search for extra-terrestrial intelligence, which scans the heavens for extra-terrestrial radio transmissions—is doomed to fail.

The particle physicist Steven Weinberg once wrote: "The more the universe seems comprehensible, the more it seems pointless." My analysis of science suggests a corollary aphorism:the more the universe seems comprehensible, the more it seems improbable. The most wildly improbable feature of the universe is the

The opposite of a correct statement is a false statement. But the opposite of a profound truth may well be another profound truth.

Niels Bohr,
Danish physicist
(1885-1962)

2. COSMOS, GOD AND US

The **myths** of science

Myth, religion and science have more often than not proved inseparable in addressing the eternal imponderable: why something rather than nothing?

MARCELO GLEISER

BRAZILIAN-BORN PHYSICS PROFESSOR AT DARTMOUTH COLLEGE (U.S.),
AUTHOR OF THE DANCING UNIVERSE: FROM CREATION MYTHS TO THE BIG BANG (PLUME, 1998)

Since the dawn of civilization, humankind has marvelled at the skies and at Nature's myriad creations. This sense of wonder was deeply interwoven with a sense of fear: Nature's dual role as creator and destroyer has puzzled and polarized our perceptions of the cosmos. As a way of establishing a degree of control over the apparent unpredictability of natural phenomena, gods were held responsible for these conflicting manifestations. In short, Nature was deified.

The question of why there is something rather than nothing was a crucial part of this process. All cultures have attempted to provide an answer to the mystery of creation, and our modern scientific tradition is no exception. Perhaps more surprisingly, there is an intriguing correspondence between answers suggested by mythic narratives and those suggested by scientific research. The crucial difference, of course, is that the scientific process is capable of weeding out explanations which do not measure up to observations, while those based on myth are held true on the basis of faith alone.

Greece and reason

Creation myths can be divided conveniently into two kinds: either the cosmos appeared at a specific moment in time marking the beginning of history, or it has always been "there." Myths with a creation event describe time in a linear fashion, with a beginning, middle and, as in the Christian narrative, an end. Myths without a creation event may consider time to be either unimportant or cyclic. Within these two sets, we encounter an enormous variety. Starting with the "no creation myths," the two possibilities are: an eternal, uncreated cosmos, as in the narrative of the Jains of India, or a cyclic cosmos, continuously created and destroyed, as beautifully represented in the Hindu tradition by the dance of Shiva.

The first and by far the most common "myth with creation" invokes a deity or deities who create the world, as in the Judaeo-Christian myth of Genesis. A second possibility is that the world was created out of nothing, without the interference of a god; this is what the Maori people of New Zealand have in mind when they sing, "from nothing the begetting, from nothing the increase. . . ." A final possibility is that the world appeared spontaneously from a primordial Chaos, where order coexists with disorder, Being with Non-Being.

The religious nature of the creation event has permeated scientific thought since its origins in Ancient Greece in the sixth century BC. As the Greek philosophers pondered the physical mechanisms that created the world and controlled its motions, many assumed an organizational principle based on rational design, attributed to a "Demiurge" by Plato or to the "Unmoved Mover" by Aristotle. Plato was a true heir of the Pythagorean tradition, which saw the world as a manifestation of Number, arranged and combined to create the harmonies perceived by the senses. The emphasis on a creation event was somewhat left aside, being substituted by the importance of reason in understanding the workings of Nature. The philosopher, in his search for rational meaning, was in effect elevating himself to a higher level of existence—that of the Demiurge's mind. To understand Nature was to understand God, or, in an oft-quoted aphorism, to understand the mind of God.

To understand Nature was to understand God, or, in an oft-quoted aphorism, to understand the mind of God.

This tradition reappeared in the West during the birth of modern science in the Renaissance. The great natural philosophers that spearheaded the so-called Copernican Revolution were all, to a greater or lesser degree, deeply religious men, who saw their scientific work as an integral part of their religious beliefs. Thus, Copernicus himself was a canon of the cathedral in Frauenberg, a reluctant revolutionary who sought to reconcile the arrangement of the celestial spheres with the Platonic ideal of circular motions with constant velocities. His model of the solar system was an elegant compromise between the old and the new, looking back at Plato and forward at the aesthetic principles of his time. His great opus, *On the*

Revolutions of the Heavenly Orbs, was dedicated to Pope Paul III, in the hope that the Church would recognize the need for a reinterpretation of the Scriptures based on the new astronomical thought.

It was through the work of Giordano Bruno and, more importantly, Johannes Kepler and Galileo Galilei, that the Copernican Revolution was enacted. Kepler was deeply influenced by the Pythagorean tradition, a number mystic who believed geometry to be the key to the cosmic harmony. His three laws of planetary motion are a powerful illustration of how the scientific output of a great mind can be a byproduct of a belief system tempered by the analysis of data.

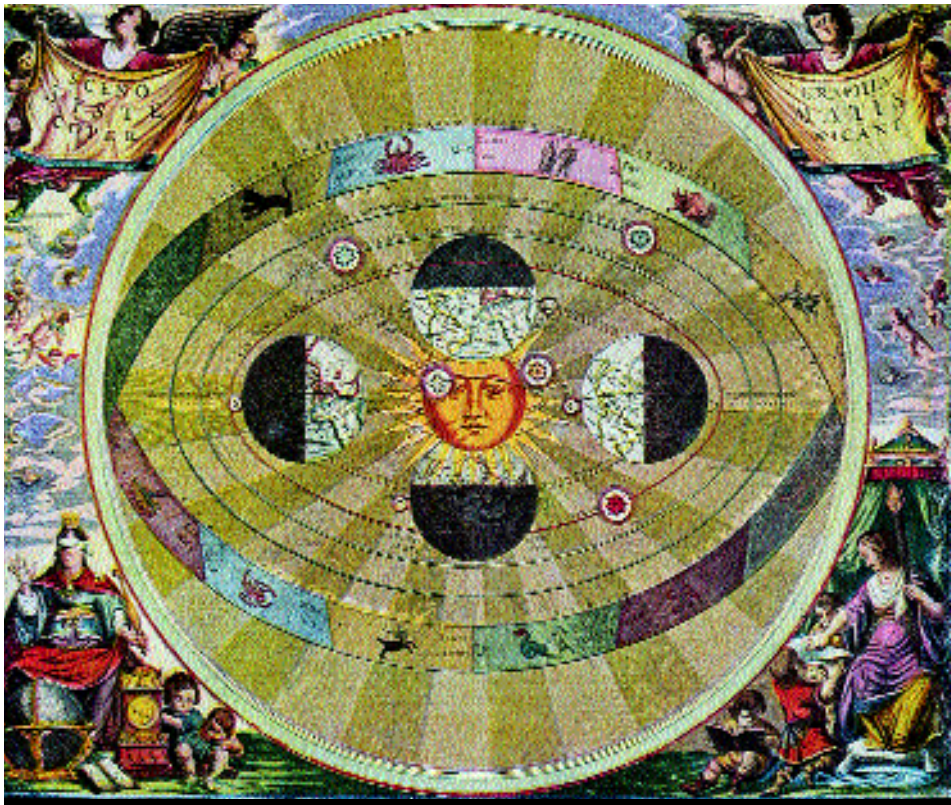
No final truths

Galileo's now famous tribulations with the Church were also a product of his beliefs. A pious (and overconfident) man, Galileo took as his personal mission to reset the course of Christian theology, preaching to the Church leaders the importance of accepting the new cosmic design. The clash was unavoidable, and in 1633 Galileo was forced to abjure his conviction in the Copernican system. Not for long, though, for soon after Isaac Newton put forward his three laws of motion and his universal theory of gravity in 1687, the sun-centered cosmos became widely accepted. To Newton, the cosmos was a manifestation of God's glory, infinite in extent and sublime in design.

During the twentieth century, the Newtonian universe was substituted by a curved Einsteinian universe; Einstein showed how matter and energy can bend space and alter the flow of time, endowing them with an unprecedented plasticity. Nowhere is this more spectacularly displayed than in the expansion of the universe itself, discovered by Edwin Hubble in 1929. Once again, the question of origins came back to haunt scientists: if the universe is expanding, there was a moment in time when all matter was squeezed into a very small volume. Astronomy was proclaiming that the universe did have an origin, after all. A cry of dissent emerged from Cambridge University via the proposal of the "steady-state model," where the universe never had a beginning in time. With the discovery that the whole cosmos is immersed in a bath of microwave radiation in the 1960s, the steady-state model was abandoned by most cosmologists; the "big-bang model" has since been accepted as the one which best fits the data.

Can science "explain" the age-old question of Creation? Certainly, physical models describing the origin of the cosmos can and have been proposed, at least since the 1970s. But these models face a serious technical obstacle: the lack of a proper theory to describe physical processes at the enormous energy scales prevalent during the first moments of cosmic history. They could be called scientific creation narratives, at least until they can be placed on more solid theoretical ground. We see old themes coming back, dressed in scientific jargon. In some models the universe was born out of "nothing," a quantum vacuum populated by all sorts of ephemeral energy fluctuations; others see the beginning as essentially chaotic, with an ordered cosmos emerging homogeneously in three dimensions.

Some of these models of creation make predictions about measurable properties of the universe, which can be used to test and refine them. Yet it may be hard to rule out all alternative models, which may also be compatible with these measurements. The best that we can hope for is a workable model of cosmic origins, compatible with observations but open to changes. Scientific inquiry is after all an ongoing process—there is no final truth, only approximations to the truth. Furthermore, science, at least as it is formulated at present, cannot answer questions concerning its own origin: we do not know why the universe operates according to the laws we have uncovered and not others. This essential incompleteness of science suggests a new form of complementarity between science and religion; religion does not exist to cover the holes of our scientific knowledge, but as a driving force behind scientific inspiration. Through our search for knowledge we uncover our true nature, fuelled by the same sense of mystery which filled our ancestors with awe. ■



Copernicus' vision of the planets, from a 17th-century illustration.

2. COSMOS, GOD AND US

The highest summit: **God** meets the **big bang**

Are science and religion inseparable twins or hostile strangers? Could a third party—philosophy—act as a bridge between the two?

DOMINIQUE LAMBERT

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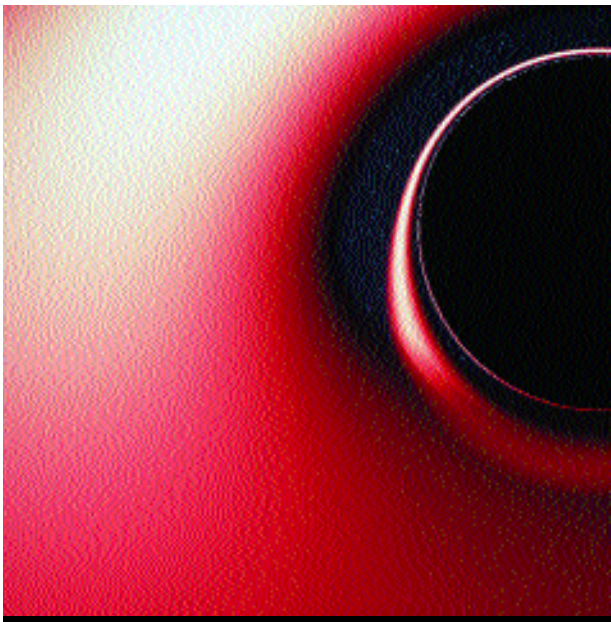
"There were two ways of arriving at the truth. I decided to follow them both," declared Georges Lemaître, one of the fathers of modern cosmology and also a Catholic abbot[1]. "Nothing in my working life, nothing I ever learned in my studies of either science or religion has ever caused me to change that opinion. I have no conflict to reconcile. Science has not shaken my faith in religion and religion has never caused me to question the conclusions I reached by scientific methods."

What relations are there between modern science and theology, understood as a rational explanation of a religious tradition? Are the two entirely separate, do they overlap or are they just complementary?

Lemaître, a defender of "dissonance" between the disciplines, argued that the approaches of science and



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Was this the beginning? An artist's

1. *Interview in New York Times Magazine, February 19,1933*
2. *Rock of Ages: Science, Religion and the Fullness of Life (Ballantine Books, 1999)*

Steven Weinberg*: Towards a final theory

"I'm reasonably sure that we will have a final theory from which all the regularities in nature can be deduced, but I am also reasonably sure that the final theory will leave us with a mystery: why isn't the theory something else, such as a theory with nothing at all, or a theory with just two particles endlessly in orbit around each other. The best we can hope to do is discover a theory that is logically fragile, in the sense that any small change in the theory would lead to logical contradictions.

On a more mundane level, there are limits to science that are not so fundamental but as a practical matter we will probably not be able to transcend. For example, the final theory may very well be something like string theory, but I cannot conceive of how we will ever directly produce structures that are 17 powers of ten smaller than those probed in the laboratory today. Likewise there's a wide class of cosmological theories in which our big bang is one of many that go off all over the universe, though in principle we will never observe the others. In both cases the theory will be successful or not depending on whether its predictions for things we can observe are correct.

As for religion,whatever reasons it provides still raise the question of why: why should there be deities with certain characteristics? In fact the more you learn of physics, the less you see of what may be regarded as purpose."

* Professor of Physics, University of Texas at Austin, Nobel Prize for Physics (1979)

John Leslie*: Inside the divine mind

"Cosmology can give us speculative stories that are very much worth taking seriously. But at the moment science cannot give us any confidence that these stories are correct. The stories are all about how this universe came into existence against the background of the laws of physics, and there's a question of why there are any laws of physics, and why they should apply to anything.

Let's suppose you had a completely empty situation.What would there be in that situation which could create a universe? Well, first note that the situation couldn't be entirely empty because it would be full of all sorts of facts—for example, the fact that 2+2=4. I don't think you can get rid of facts like that just by banishing the universe from existence, because these are facts about possibilities and hold no matter what. There would also be ethical facts:for example, it would be a fact that the emptiness was in one respect bad because you could have a really good situation instead, a wonderful cosmos.

If Plato was right in thinking that Value itself acts creatively, then the cosmos must be the very best possible cosmos. It then consists of an infinite number of minds, each knowing everything worth knowing:minds we might want to call divine. The structure of the universe is just one of the things worth knowing, and all of us exist inside one of those divine minds. This is a pantheistic view—that the structure of the cosmos is simply the structure of divine thinking."

* University Professor Emeritus of Philosophy, University of Guelph, Canada, and author of Universes (Routledge, 1996)

INTERVIEWS BY IVAN BRISCOE

religion were completely separate and insulated from each other. Because they belong to totally different areas of knowledge, he added, science and theology not only do not overlap, but are so far apart they cannot even influence one another.

This conclusion is not upheld by other supporters of dissonance. According to the NOMA (Non-Overlapping Magisteria) principle proposed by U.S. palaeontologist Stephen Jay Gould[2] andothers, science and religion supply *magisteria*—fields of knowledge—that do not encroach on each other, but are not entirely separate; an intimate dialogue is possible between them.Gould uses the metaphor of oil and water, two elements that do not mix but can remain in very close contact. The contours of their separation are complex and fluid, since both can move back and forth into places occupied moments before by the other. Science and religion, in short, are inseparable but radically different,friends but never partners.

representation of a black hole.

Transcendental gaps

Not true say the supporters of "correspondence," who base their viewpoint on the notion that scientific data can be directly useful to religion. According to this approach,concepts in these two fields can link up or even agree, so that theories of the big bang and Creation may interact to their mutual advantage. But this position raises a host of questions, particularly over the nature of knowledge:is science not impoverished or cheapened by confusing all or part of it with religion? Does a concept such as Creation not mean very different things in different religious traditions and in the mouths of scientists, for whom it has a precise technical significance?

The essential weakness with this approach is evident in the concept of a "God particle." Since ▶

"Religions die when they are proved true. Science is the record of dead religions."

Oscar Wilde, Irish wit, poet and dramatist (1854-1900)

Michael Heller*: The limits of scientific understanding

"There is a great temptation for the scientist to identify the limits of rationality with the limits of scientific method—or, to put it in a more picturesque way, to identify the limits of the method with the limits of the universe. This temptation is so powerful because the scientific method is the easiest kind of rationality and can efficiently distinguish what is scientifically valuable information from what is not.

The nature of the big bang is a purely scientific problem. To "explain" it as a result of God's action is like ascribing thunder to the bad temper of Zeus. I think the really important question lies elsewhere:namely, where do the laws of physics come from?

There are currently two ways of answering this. One is to show that on a fundamental level there reigns complete anarchy and the laws of physics are just effects of purely random averaging processes. The other is to imagine a set of all possible universes, each of them with different physical laws. We then happen to be living in a highly ordered universe because in all other universes the life of beings like ourselves is excluded.But can such probabilities be an ultimate explanation? Why does the universe—or the set of all universes—have this property of probability? Here, I think,we are touching the real limits of our understanding of the universe.

The only way to get rid of such questions is not to ask them. But that would go against a criterion of critical rationality:one should not cease to look for further arguments as long as something remains to be argued for."

* Professor at the Faculty of Philosophy of the Pontifical Academy of Theology, Cracow, Poland

Tsevi Mazeh*: The beauty of the world

"Science cannot tell us why and what for, and in a sense science is limited to the technical details of how the world works. I think there is no problem with saying God was in the beginning, that God set the world rolling and decided upon its rules. But as for the question of God interfering during the history of the universe—that is something I believe, but which I do not fully understand.

My religion [Orthodox Judaism] does not influence my work as an astronomer, but it does make me appreciate God and the beauty of the world. I have been teaching a course on binary stars, in which there is a mathematical formula describing perfectly the stars' motion.In my eyes it is a miracle that the human mind can find such beautiful mathematical tools to explain the motion of the world—I see that as one of the miracles of the world that God created.

As for Chapter 1 of Genesis, you have to realize that it has a core and it has details. The core is the theological message:there is one unified God. When the Bible was written, this was a complete revolution and actually doesn't make sense when you look upon the world and see its forces fighting each other. The writer of Genesis had to convey this message in some cosmological terms, so he chose the cosmology of his day. He could not mention the big bang, the speed of light or atoms. Instead, he spoke in terms understandable to the people of that time."

* Professor of Astronomy at Tel Aviv University

scientists have no quantum theory of gravitation to describe what happened in the first few moments after the big bang—there is a scientific gap to be filled—the initial creative impulse is attributed to divine power. But God provides no explanation at all. Reduced to a simple physical cause within other physical causes, God also loses his divinity to become just another element in the material world.

Dissonance avoids this trap by allowing a calm dialogue between scientists and theologians that respects each other's independence of thought: they agree not to exploit bits of each other's field of knowledge to advance their own. But is this division perhaps too radical, depriving each side of elements that could be useful for their own thinking?

Thus the need for a third position that rejects all blending of science and theology advocated by supporters of correspondence, but establishes an indirect dialogue between them via a go-between—philosophy in the broadest sense. The dialogue is also asymmetrical, since it encourages theological debate on the basis of scientific knowledge rather than the other way round.

This perspective begins by recognizing that science inevitably raises philosophical questions which it cannot answer, such as ones about meaning and ethics. Philosophers can then draw on religious traditions among other resources to search for answers. These answers are of little use to scientists in their everyday research, but may help them deal with the kind of questions every human being runs up against. And theology in turn can benefit from philosophical work inspired and fertilized by science. This pathway from science towards religion is thus the fruit of work that has to be carried out continually as scientific knowledge advances: questions are raised, and philosophical responses generated that must at some stage take account of religion.

Unravelling the beginnings

Let's go back to the example of the big bang. A scientist from the school of correspondence could say it was equivalent to Creation in the theological sense. But this assertion would not be scientifically legitimate:physics is based on natural causes alone, while Creation comes from divine and therefore metaphysical intervention. As a result, the issue of the purely physical origin of the universe "remains entirely separate from any metaphysical or religious question," according to Lemaître. The theory of the big bang hence does not presuppose any special religious belief, contrary to what some scientists thought in the 1950s.

Dissonance, which rules out all dialogue between cosmology and theology, is no more satisfactory. But an

Lee Smolin*: Cosmological evolution

"A key issue is understanding the fine-tuning of the universe: how did it come to be that the parameters that govern elementary particles and their interactions are tuned and balanced in such a way that a universe of such variety and complexity arises? The probability that a universe created by randomly choosing the parameters will contain stars is one chance in 10^{229}.

The universe is improbable, and it is improbable in the sense that it has a structure which is much more complex than it would be if its laws and initial conditions were chosen more randomly. Thus we seek a kind of explanation which is checkable, which is falsifiable, and which is based on some hypothesis of natural phenomena. Broadly speaking, biology and natural selection are the most successful examples of a theory that addresses such questions.

In the case of the universe, this leads to the hypothesis of cosmological natural selection:in other words, that our elementary particles are the way we find them because they make the production of black holes, and thus the production of new "universes," much more likely.

If it is true that the big bang was not the beginning of the universe but an event that came from another part of the universe, whether a black hole or something else with a prior structure, then it's very possible that observations over the next few decades will help us—just as by studying the ripples in water, you can measure the shape of the rock that caused them."

* Professor of Physics at Pennsylvania State University, author of The Life of the Cosmos (Oxford University Press, 1997)

Seyyed Hossein Nasr*: Be, and there is

"Science by its very nature can deal only with one level of existence, physical existence. Science also relies on the study of events in time and space. The scientist therefore pushes towards the beginning, but find its impossible to get to the beginning itself since it is beyond material existence and beyond the spatial or temporal.In contrast,most religions—with exceptions, such as Confucianism—have spoken about the origin of the universe.

Those who accept the religious point of view, such as myself, can say a great deal about the origins of the universe. We believe that the reality which brought the universe into being has also sent us a revelation in knowledge of the origin of that universe. In the case of Islam, this revelation comes first of all from the Koran, which describes the creation of the universe as coming from the word of God, recounted in the very famous verse of Chapter 36 in which God says "Be, and there is."

Until the 17th century, science from East to West was aimed at studying the traces of God's wisdom in his creation. But the Cartesian philosophy that undergirds the scientific revolution created a division between the knowing subject and the known object: modern science considered its goal to be the study of pure quantity, and tore away all qualitative aspects of nature—all its spiritual elements.

Every ten years there are new cosmological theories and views. But I do not really take these to be steps towards understanding the ultimate structure of the universe since we are dealing with so many unknowns. It's as if you knew one inch of a line and extrapolated it straight to the moon."

* Professor of Islamic Studies at George Washington University

"God as an Architect", by William Blake.

intermediate philosophical discussion about the meaning of the big bang as the physical origin of the cosmos can help theologians unravel the links and differences between notions of physical beginning, metaphysical beginning and divine Creation,and see more clearly the purely theological meaning of the latter.

Creation in the theological sense can mean the sudden physical appearance of the world for divine reasons, but it can also mean a relation that God uses to keep the universe in existence by giving it physical shape. This "sudden appearance" cannot be regarded as the start of a process in physical time because it is itself the origin of space, time and matter.

Furthermore, this "Creation link" cannot be seen as a physical cause because it is in fact the cause of all physical causes. New theological ways of describing the relations between time and eternity, between God and the world, can flow from this philosophical clarification. It also makes for better understanding of the range and limits of science.

For some, science and religion are inseparable but very different friends. For others, they are friends only linked by a third party. For get others, they are friends that are in fact true twins. And finally, they are viewed as two people who are not friends at all because they never meet. In short, a set of bonds running all the way from fusion to fission. ■

"The brain—is wider than
the Sky—
For—put them side by side—
The one the other will contain
With ease—and
You—beside"

Emily Dickinson,
American poet
(1830-1886)

2. COSMOS, GOD AND US

Out of **butter** and **water**: the Hindu creation

In the classic myths of Hinduism, there is no primeval emptiness: just different stages of gods and the universe, recycling themselves like crops

SUDHANVA DESHPANDE

ACTOR AND DIRECTOR WITH THE DELHI-BASED THEATRE GROUP JANA NATYA MANCH

There is no single Hindu myth of origin. There are as many myths as there are texts; sometimes, the same text has more than one. The earliest myths date back to the Rig Veda, the first of the four Vedas, composed over a period of time, though certainly before 1000 BC, and eventually committed to writing many centuries later.

Contrary to what some believe, the bulk of Rig Vedic hymns—all told, there are 1028 of them, spread over ten books—are not spiritual or metaphysical at all, consisting mostly of tributes to an entire pantheon of anthropomorphic gods. But books one and ten, which coincide with the emergence of *varna*, the four-fold hierarchical division of society, which rapidly led to the proliferation of hundreds of castes, also contain the origin hymns.

The most celebrated of these is the hymn that contains the earliest known reference to *varna*. Creation is the result of the sacrifice of Purusha (Man), the primeval being, who is all that exists, including "whatever has been and whatever is to be." When Purusha, who had "a thousand heads, a thousand eyes, a thousand feet" was sacrificed, the clarified butter that resulted was made into the beasts which inhabit

the earth. This same sacrifice produced the gods, Indra (the menacing king of gods), Agni (Fire), Vayu (Wind), as well as the Sun and the Moon. From Purusha's navel the atmosphere was born; his head produced the heaven; his feet produced the earth; his ear the sky. The four *varnas* were born too: the mouth was the *brahman* (priest); the arms the *kshatriya* (warrior); the thigh the *vaishya* (general populace);the feet the *shudra* (servant).

Primeval incest is the other method by which creation takes place in the Rig Veda, and this idea recurs throughout Hinduism. Later mythology claims Manu, the first man, gave birth to the human race through the act of incest; Manu himself is also born of incest that the creator indulges in. By the time we come to the texts known as the Puranas (dates between 300 and 1500 AD), the story of creation becomes more complex: the creator of the universe was the god Brahma, who came from the primeval waters, and was *swayambhu* (self-existent). Brahma transformed himself into a giant boar (*varaha*) to bring forth the earth from the depths of these waters. The first man,

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Brahma (centre-top) emerges from a lotus flower.

Manu, was born directly of Brahma. Manu was a hermaphrodite, and created two sons and three daughters from his female half.

What is striking in all this, of course, is that none of these stories actually say how the universe began. There is no sense of things being created out of nothing, the stuff of the universe only happening to be reused and recycled periodically, like in a giant ecofriendly enterprise. In a sense, of course, this is a natural outcome of the Hindu view of the eternally recycling universe, that goes through the four successive periods, *yugas*, forever condemned to the cycle of regeneration and destruction. The four *yugas* are said to be respectively 4800, 3600, 2400, and 1200 god-years long. A god-year, in turn, lasts 360 human years. The quality of life, as well as of humans, progressively deteriorates in each successive *yuga* until we reach the present dark (kali) *yuga*, which will end in the great universal deluge, followed again by a new golden age and the birth of man from Manu.

This great cosmic cycle, eternally chasing its own tail, this depressingly monotonous ebb and flow in which all illusion of forward movement is actually retrogression, fairly accurately sums up the Indian peasant's life over centuries. The hard summer is followed by the great deluge of the monsoon, which rekindles the eternal hope that at last hunger, misery, and want will come to an end. Thus every agricultural cycle is actually the great cosmic cycle in microcosm. Practically all festivals in various parts of India coincide with the major punctuations in this agricultural cycle; for instance, even as I write these lines in late March, the traditional Indian new year is being celebrated in most regions, now that the crop is ready.

A visit to the barber

To the extent that India is still a predominantly agricultural society, these festivals, and the various rituals that go with them, are an organic part of people's lives, and not just corporate inducements to an urban elite to consume more and more in the globalized marketplace. Yet, since these festivals and rituals have actually evolved over a very long period of time, they are now most often taken for granted; like the self-existent creator, they just exist, with neither beginning nor end. For most practitioners of these rituals, much of the original meaning is either unimportant, or simply lost under centuries of cultural sedimentation.

Yet ideas persist over centuries and pop up at you when you least expect them. Last week, I needed a haircut, and so I went to the barber who has performed this service since I was about ten. It is a veritable ritual, evolved over two decades or so. It begins with his magnanimously offering me tea, and ends with his never returning change. In between, he asks about my family, I about his; he checks if I am still off smoking, I if he is off drink. Through all this, of course, we discuss politics, sports, and anything else of topical interest. This time, I asked him how he was told the universe came into being. He laughed, snipped off a tuft of hair on my forehead, and said: "Who knows how all this was created? Who was around to see? Even the gods were born after something existed, so who can tell what happened when nothing existed?"

My barber has not read the Rig Veda. But if he were to, some day, he will be struck by the following hymn:

Then even nothingness was not, nor existence.
There was no air then, nor the heavens beyond it.
Who covered it? Where was it? In whose keeping?
Was there then cosmic water, in depths unfathomed?
But, after all, who knows, and who can say,
Whence it all came, and how creation happened?
The gods themselves are later than creation,
So who knows truly whence it has arisen?

(Rig Veda, X, 129) ■

2. COSMOS, GOD AND US

Fresco

A SHORT TALE BY ALASTAIR REYNOLDS

AUTHOR OF REVELATION SPACE (VICTOR GOLLANCZ, 2000) AND A SCIENTIST WORKING WITHIN THE ASTROPHYSICS DIVISION OF THE EUROPEAN SPACE AGENCY

Jupiter and its moons.

On the day that the blue ones stopped transmitting, the caretaker was doing its rounds of the Eye, humming and pottering among the other, duller maintenance robots.

Then, when the news came in, it stopped humming.

Near the heart of the Eye—the vast radio telescope floating beyond the orbit of Jupiter—was a gigantic spherical tank which had once been used to store the water the humans had needed during the construction. They had lived in it, too—dwelling in pressurized cabins surrounded by water, shielded from radiation.

Now they were gone—long gone—but the midnight blue tank remained.

Like, the caretaker had thought one day, a huge blank canvas.

☆☆☆

Until the coming of the Eye, no radio telescope had been sensitive enough to pick out signals of intelligent origin from the mush of cosmic background noise. But then the feast had begun: a tsunami of knowledge almost beyond human comprehension. Yet the messages showed that humanity was still fundamentally alone. All the signals had originated in other galaxies, often at distances that bordered on the cosmological. They had been sent hundreds of millions of years ago, when the dinosaurs were still evolution's cool new idea.

But there was a more disturbing thing even than the loneliness.

At any one time the Eye was picking up the messages from about a hundred civilizations, but each only stayed active for a few centuries before falling silent. The net number stayed roughly constant because new species were always popping up and discovering radio astronomy, but they too would be doomed to spend only a relatively short amount of time among the hundred. For a few glorious centuries they would broadcast their cultural legacy into the sky; enriching the knowledge of the other listening cultures.

But then—it was often around the time they started discovering some of the more interesting things that could be done with subatomic particles—they would stop sending.

Usually without much warning.

☆☆☆

It shouldn't have bothered the caretaker.

But in tending the Eye it found that it became quite attached to some of those transmitting cultures. It became absorbed in their histories; fascinated by their biologies and outlooks.

It hummed their music and pondered their art.

And waited with deep, mounting sadness for the day it always knew would come; the sudden, roaring silence from that part of the sky.

☆☆☆

It moved to the part of the Fresco which recorded the senders in a distant galaxy in the constellation Sculptor.

The caretaker had marked the tank with faint lines of celestial latitude and longitude. At the precise co-ordinates of the transmitting civilization, it had painted a spiral galaxy much like our own; an impressionistic swirl of white and ochre. It was one of the first galaxies that the caretaker had painted, and while it had gained proficiency since—there were better ones dotted all around the Fresco—there was a certain charm to this effort which appealed to it.

Two thirds out from the core, the caretaker had marked the location of the transmitting culture's solar system.

It thought of them: blue, tentacled aquatic beings with a reproductive system so intricate it had taken the caretaker decades to work out how many sexes they had. Their music had been even trickier; sounding at first pass like synchronized drowning. But the caretaker had persisted, and after a while it had even caught itself humming some of the more accessible bits.

But they were gone now.

Silent.

☆☆☆

Nothing for it, then.

With sadness in its heart—but at the same time emboldened by the execution of a solemn task it knew must be done—the caretaker prepared the precise shade of midnight blue it needed. When it was ready, it carefully stippled the galaxy into oblivion, like a master picture restorer removing a blemish. The caretaker was very good at its work, and when it was done there was no sign that the galaxy had ever existed.

The Fresco was up-to-date, but it would not be long before it had to be changed again.

Art is long, it thought. *And life short.* ■

More than just the truth

Truth commissions can set in motion a process of grieving and recovery, but they are not the only answer to confronting crimes of the past. Trials are critical, while traditional healing practices can also assuage wounds

PRISCILLA B. HAYNER

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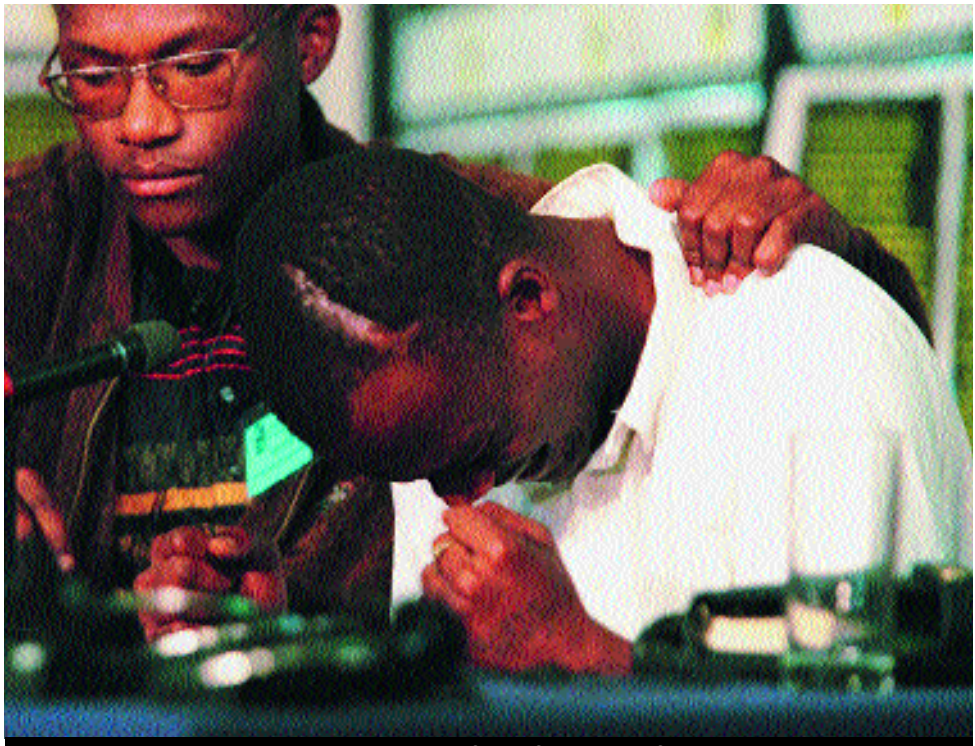

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A torture victim breaks down as he testifies before South Africa's truth commission.

When nations go through a transition from a repressive regime to a democracy, as many have in recent years, a state and its people are often left with a legacy of violence, bitterness and pain. Because it is not always possible to prosecute hundreds of perpetrators, many new governments have turned to mechanisms outside the judicial system to confront the horrific crimes of a prior regime.

More than 20 such commissions have been created over the past two decades, mostly in Africa and Latin America (see box). As they are more widely used and studied, it has become clear that they fill a very different role from judicial inquiries and trials. They paint a larger picture, looking at many thousands of victims, whereas trials (which are critically important as well) must, by definition, focus on specific events of wrongdoing, and specific perpetrators. Truth commissions can be defined as official, temporary mechanisms established to investigate a pattern of past human rights abuses or violations of international humanitarian law. As a transitional tool, they are charged with investigating and reporting these abuses, and recommending reforms in order to prevent further abuses in the future. In the process, they serve to acknowledge formally past wrongs that were silenced and denied.

Perhaps the most controversial and publicised of these was the South African Truth and Reconciliation Commission, set up in 1995. It is the only commission to date which had the power to grant amnesty to individual perpetrators. The very public nature of the hearings, with both victims and perpetrators testifying in front of television cameras, resulted in the country as a whole reflecting on its history and coming to a new understanding of the past.

To be granted amnesty, perpetrators were required to make a request in writing for specific crimes, tell the full truth about the event, and prove that it was politically motivated. Thus, it was not a full amnesty: if someone killed ten people and applied for amnesty for only five, he or she could still be prosecuted for killing the other five. Also, amnesty could be denied if it was found that the applicant did not tell the full truth or that the crime was motivated out of personal spite or ill-will, rather than for political reasons.

High expectations

Though the commission had a profound effect, it also shed light on the limitations of such exercises. Often, the time allotted for the commission to complete its work was too short, and it was impossible to verify and reach conclusions on the thousands of cases presented. For many victims, it was painful to watch their perpetrators walk free after admitting to heinous crimes. The expectations from the commission were too great from the start. South Africa's experience teaches us that we can't expect the truth process to resolve all issues pertaining to past conflict and abuse. Reconciliation and recovery is a process that can take generations.

There is no one truth commission model. Countries respond to legacies of massive political violence in different ways. Mozambique, for example, is right next to South Africa, and its transition took place almost exactly at the same time. Yet here, there was no interest in digging up the past: the victims and general public were exhausted from the war and didn't want to talk about it, while the political leadership on both sides of the conflict were also uninterested in looking closely at the past. Each nation must determine what span of time to consider, what acts or events to investigate, and under what rules. The differences will range from whether a commission chooses to hold public hearings, as in South Africa, or undertakes its investigations behind closed doors.

Past experience shows that there are some basic requirements for judging

whether a commission's exercise is likely to lead to credible results that fairly reflect the concerns of all society. Truth commissions must have operational independence, but at the same time, be given the necessary political and governmental support for their work, often including direct financial support from the government.

We are likely to see stronger commissions in the future, as the lessons of past experiences are incorporated into new and more inventive models. The new commission in East Timor, for example, makes creative use of local customs to promote healing and reconciliation. The commission has been set up, in part, to help facilitate the return of low-level perpetrators who are still in West Timor. These include members of the militia who were not responsible for killing, raping or organizing violence, but who might have taken part in the burning or looting. It is believed that such persons would be safe from acts of revenge once they have admitted to their crimes, apologized for them and agreed to carry out a community service sentence. Likewise in Sierra Leone, the Truth and Reconciliation Commission that is now being formed is likely to turn to traditional and religious leaders to facilitate its work on a local level. Where appropriate, it may facilitate such practices as cleansing ceremonies as a way of recognizing and honouring past events. In Mozambique, traditional mechanisms were in place that allowed people to process conflict and pain in their own way. When combatants came home, for example, they often went through a healing ritual where their past sins were seen to be washed away. It is important for a country to consider the indigenous mechanisms that may be in place that can help it to counter a painful past, with or without a complementary truth commission process. ■

This article is based on an interview.

A POPULAR FORMULA

The first truth and reconciliation commission was set up in 1974 by the Ugandan dictator Idi Amin under pressure from human rights groups and the international community. Not surprisingly, his regime refused to make public the report or to implement any of its recommendations.

Other truth commissions established in the 1980s fared better. Nunca más, the report by Argentina's commission to investigate disappearances under its military dictatorship, became a national bestseller and led to the prosecution of several generals. Spanish judge Balthasar Garzon used the Chilean Truth Commission (1990-91) report as his primary information source in issuing an arrest warrant for dictator Augusto Pinochet in October 1998. Guatemala's Historical Clarification Commission (1997-99) and South Africa's much-publicized Truth and Reconciliation Commission (1995-2000) have been lauded for helping citizens of those countries come to terms with their traumatic pasts.

Truth commissions have recently been set up in Nigeria, Panama, East Timor and Sierra Leone, while other countries, including Bosnia, Serbia, Mexico and Burundi are exploring the option. Canada may establish one to investigate the treatment of its native peoples. ■

MORE THAN JUST THE TRUTH

Revenge in the making

Children in Bosnia are growing up learning that their neighbours are enemies. Civic groups say that a truth commission is the only way to defuse brewing ethnic hatred

JAKOB FINCI

PRESIDENT OF THE NATIONAL COORDINATING COMMITTEE FOR THE ESTABLISHMENT OF THE TRUTH AND RECONCILIATION COMMISSION IN BOSNIA HERZEGOVINA

When truth commissions were set up in Latin American countries such as Argentina, Chile, and El Salvador, they were justified because the systems of abuse there had been designed to hide the facts. Torture and related abuses were committed largely in secret; crimes like "disappearances" were intended to erase any trace of the victim or the crime. Hence the compelling need to uncover and acknowledge the truth.

In Bosnia, such a commission is not needed because of a hidden truth, but because of multiple "truths," each with a distinct ethnic vein. Nationalists from the three ethnic communities involved in the recent war propagate a history that portrays their group as the one and only victim of mass abuses, depicting the other two as evil perpetrators and monsters. Three separate war crimes commissions, dominated respectively by Bosnian, Croat and Serb perspectives, have focused on the victimization of their own group.

Owing in no small part to the legacy of communism, people in Bosnia Herzegovina have long been accustomed to a "top-down" approach, by which they passively let leadership determine their fate. Shedding this mentality has been a slow process, but citizens are sending out a clear signal that they are ready to confront the past with an eye to shaping a better future. On no other issue is this more obvious than the current effort to establish a Truth and Reconciliation Commission (TRC).

In January 2000, an extraordinary conference in Sarajevo on the proposed TRC brought together a diverse group of ▶

80 civil society leaders from both the Moslem-Croat Federation and the Serb Republic. Representatives from human rights groups, victims' associations, religious orders, political parties, academia, youth groups and others explained why they thought the TRC was vital to reaching durable peace. Independent media re-broadcast the entire eight-hour discussion. This broad-based grassroots citizens' coalition has now established a National Coordinating Committee for Establishment of the Truth and Reconciliation Commission. This is an important step in the processes of both democratization and reconciliation in Bosnia. To date, over 100 NGOs, political, religious and civic leaders have signed a petition calling for such a Commission.

One of its main goals is to enable historians to write one history of the country. For now, we have three different histories, each teaching our children that our neighbours are our enemies. Continuing like this, we cannot expect anything more than a new war in 20 or 30 years.

Finally, some have suggested that the TRC should not be established until the War Crimes Tribunal in The Hague finishes its work. This would only postpone for at least another five years a process that many believe is essential to reconciliation. Five years for the three competing nationalistic versions of history to become further embedded in the collective psyche of each group. A boy who was ten years old when the recent conflict began has already reached the age of military service. With every year that children are raised on accounts of recent history that demonize other ethnic groups and refuse to acknowledge their suffering, it becomes more likely that this young generation will grow up to fight. It is a common belief that if NATO peacekeeping troops withdrew tomorrow, the country would likely descend anew into bloodshed and division. To make the departure of these troops possible, it is imperative that Bosnia take the TRC route.

To prevent a new cycle of violence and abuse, our society urgently needs to confront the legacy of evil committed by neighbour against neighbour, to identify the shortcomings in its political, legal and social institutions which render such abuses possible, and to begin the extraordinarily difficult and slow work of re-stitching the social fabric. Delaying such a process by several years would be both tactically mistaken and morally wrong. ■

The war's toll (1992-95)

Population	1992:	4.4 million
	2000:	4 million
Death toll:		200,000
Internment camps:		15
Refugees and displaced persons:		
	1995:	2.2 million
	2000:	782,200

Source : UNHCR, Le Monde

JEAN HATZFELD*: "LET THE VICTIMS VOICE THEIR PAIN"

I don't have much trust in the effectiveness of international tribunals. When trials and hearings are held far from the scene of the crime, it doesn't help reconciliation in the least. In the Rwandan town of Nyamata, where I spent six months, people would hear on the radio that "so and so has been sentenced to 25 years in prison" in Arusha, Tanzania, where the international tribunal for Rwanda sits. But what help is that? The survivors of the genocide are neither there to hear the trial nor to point accusations. What is said over there, before a foreign judge, leaves them indifferent.

Obviously, it would be unthinkable for justice not to be done. But after civil war or genocide, the first job of justice—precisely because it has come too late—is not so much to punish as to tell the truth, to unravel the complex nature of responsibilities, and to acknowledge the victims' suffering. Let everything be known, said and recognized! Let the victims voice their pain! Only then can the process of mourning begin, that crucial stage on the path to reconciliation. And it can only happen before the eyes and ears of those who suffered or "participated."

In Sarajevo, as in the hills of Rwanda, you hear that "the guilty must be tried here, by us." All the more so as many cannot accept that we Westerners, who stood by as the war and genocide went on, are now judging its authors. The words of Marie-Louise, featured in my book, come back to me: "foreigners usually show a routine pity towards people who endured uncomparable hardship, as if the pity was more important than the suffering itself."

Time cuts two ways. A lot has to be left to survivors. They need it to find a new footing in life. Conversely, however, time is running short for the Hutu community, which is living in terror. About 125,000 accused people are waiting in Rwandan jails. What's being done about them? And what about those who've returned home to find themselves at the mercy of denunciation and vigilante justice? The page must be turned on an era of suspicion, justice must be done so that each charged person can at last make their way back into society without fear.

Are the Rwandans capable of judging their own? Not for the moment, but we can help by training their judges and prosecutors. To ask "who will try them and how?" and to ensure there are some Hutu among the judges is a step towards dialogue. Let's allow the time it takes for the people involved to resolve this themselves, rather than turning to symbolic international tribunals set up by the West as a warning against more wars and genocides, but which don't help reconciliation at all, except the reconciliation of Westerners with their own conscience.

For now, in the hills, the genocide remains hidden, secret, wrapped in guilt and shame. This silence is killing Rwanda. Should there be forgiveness to become reconciled? I don't think so. For one, you can't forgive someone who's tried to exterminate you from your land. Second, reconciliation does not require forgiveness, but a sense that justice is being done. Deep down inside, the survivors know that life must get back on course. Because, as Francine told me, "the teachers have to return to their school blackboards."

* Author of Dans le nu de la vie (Seuil, 2000), a series of poignant accounts by survivors of the Rwandan genocide. Orchestrated by the "Hutu power," this genocide claimed hundreds of thousands of lives among Tutsi as well as Hutu moderates, from April to July 1994.

Weaving magic with the spoken word

Storytellers in Latin America have gained a cult following in the past decade. Some are delving into ancient traditions, others are spinning stories with a distinctly post-modern edge

ASBEL LÓPEZ
UNESCO COURIER JOURNALIST

Halfway through his performance, Diego Camargo notices that he's forgotten one of his characters. He asks the audience for permission to go backwards and finds the rebel climbing a tree, crestfallen and upset. To convince him to return to the story, Diego promotes him to the rank of main character, giving him the assurance that nobody will ever drop him halfway through a tale again.

To hear stories like this, fans turn up in numbers every year to the International Congress of Oral Storytelling, an event held since 1995 as part of the annual Buenos Aires Book Fair. Last time round, over 800 people flocked from Argentina and neighbouring countries, all keen to hear stories old and new, but also to learn how to tell them—those subtle tricks of timing and voice, of gestures and facial expressions.

Many were teachers eager to get children to read by adapting stories from world-famous authors, such as Isaac Bashevis Singer and Ray Bradbury, and telling them in the classroom. According to Nora Fonollosa, a narrator and researcher into children's literature, pupils often go to the nearest library to look for copies of a story they have heard, and if they can't find it,ask for another book by the same author.

But this enthusiasm is not confined to schools. Juan Moreno, from Argentina, stopped teaching literature 17 years ago and began a new life telling stories and legends from around the world in theatres, bars, universities and libraries. If they happen to be in French, English, Portuguese, German, Italian or Hebrew, he tells them in the original language. He also runs workshops for psychologists, lawyers, housewives and grandmothers. What does he teach to people from such different walks of life?

"The value of the spoken word," he says. "Words that heal and restore, that can give life but also take it away." Learning this is very important for a lawyer involved in mediation, he says, but also for social workers in hospitals and senior citizens' homes. He remembers what a despairing woman once told Dora Pastoriza de Echebarne, the pioneer scholar of oral storytelling in Argentina:"When I heard you tell the story, I didn't feel sad any more."

Witches and goblins mingle with spirits of nature

On a more material note, storytelling is said to have its bonuses. It's usually better paid than acting in a theatre, and even more enticingly, has lots of travelling thrown in. Cuban storyteller Fátima Paterson has already been twice to Liverpool, in England, to tell stories accompanied by her musicians. Every year, there are congresses, festivals and seminars, such as those in Bucaramanga (Colombia),Monterrey (Mexico) and Aguimes, in the Canary Islands.

After 15 years of slowly taking root, storytelling is now flourishing in Latin America. According to Argentine anthropologist Adolfo Colombres, the wave is not so much a revival of Latin American narrative traditions, but simply an enthusiasm for oral communication. In countries where few people read, "oral narration strangely enough encourages people to write," he says. ▶

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The continent's storytelling traditions are nevertheless very rich,a mingling of three historically oral societies: the indigenous Indian, the African and to a lesser extent, the local Spanish. "The European tradition of witches, goblins and fairy tales mix in with Indian and African traditions of the spirits of water, jungles and mountains," says Bolivian writer Victor Montoya. "There are spirits that defend nature and severely punish those who harm it, such as Marimonda in Colombia and Coipora in Brazil. Then there are the ships condemned to sail the seas forever, never reaching port, such as *Caleuche* in Chile and the *Barco Negro* in Nicaragua. And beautiful women who seduce men but when you kiss them, their heads turn into frightening skulls"

Fortunately these traditions are still alive. Oral storytellers, such as the Colombian Nicolás Buenaventura (see next article) and Mimi Barthélemy, from Haiti, are spreading them and linking up with other oral traditions.

Barthélemy was born in Port-au-Prince and gave up the comfortable life of a diplomat's wife to compile traditional Haitian folk tales and make them better known throughout the country and beyond,in Latin America and Europe. She travelled to villages to listen to local storytellers and read books on Haitian anthropology in Washington libraries.

Haiti's Mimi Barthélemy: telling stories is a political gesture.

Kindling pride in oral heritage

One of the stories she collected was about the ogre Bakulu Baka, who swallowed the sun and left the country in darkness until a benevolent god arrived with a machete and liberated it. "When I tell stories," she says, "I mention Haiti and how voodoo and Catholicism mingle there. In one of my performances, the gods of both religions join hands in common cause."

Telling stories is a political gesture for her. "When I'm before an audience, I stop being somebody else's lady. I become Mimi, a modern-day woman speaking in public places." Does she feel she's just lending her voice and body to a tradition? "Certainly not," she retorts. "It's not just folklore. I break with tradition because I give my own version of a story. By telling them in French, not just in the original Creole, I open up these stories to the world in a novel way and place them in a completely different context."

Spreading this tradition is very meaningful for Haitians, she believes. When they listen to stories, her compatriots come into close contact with an ancient tradition that is part of their heritage. They feel proud of belonging to a civilization that has invented such characters and stories. For an impoverished Haitian minority living in French Guiana,for example, listening to these stories is a mirror that can give them a more positive image of themselves.

For each place gives rise to its own style. In Colombia, for example, a movement of urban storytellers has sprung up in several towns, despite a tendency to associate the form with exaggeration and lies. Most of those involved are university students between 17 and 35 years old. Although they do not claim to be inspired by any special tradition, they are hardly cultural rookies: "We always know something, whether it's about music, film, theatre or literature, and we take the story from there," says Carolina Rueda,one of the students.

The daughter of an impassioned bullfighting fan, Rueda studied literature and worked as a theatre actress. From those experiences, she created a narrative about bullfighting based on stories she had heard since childhood, with some extra help from books about the sport. The structure of her show is rather like a bullfight,with six parts, like the six bulls that traditionally feature in an afternoon performance.

Narrative tricks

The storytellers have dropped simple, linear narration and delved into the language of films and advertising. One of them tells a half-hour story about a 30-second TV spot in which a drop of tomato sauce falls from the 22nd floor of a building and sets off a gun-battle in the centre of Bogotá.

Diego Camargo, the storyteller mentioned above who lost one of his characters in the midst of his performance, has also written a tale in 174 two-syllable words. But because it is difficult for the character to kill himself with three-syllable "*balazos*" (Spanish for bullets), he asks the audience to allow him a bit of poetic licence and ends the story with a loud "*pum-pum*!"(bang-bang!).

Through such narrative tricks, the new movement is breaking with tradition, culling inspiration from post-modern authors such as Italo Calvino and his *If on a Winter's Night a Traveller*. The Colombian storytellers have thus managed to capture a media-educated urban audience for their art, which is filling public squares and theatres.

Using both ancestral and post-modern tales, the storytellers are reviving among Latin Americans the ritual of listening to stories, those priceless moments of communication that begin for us all with the first stories we hear from our parents and grandparents. They are occasions that can spark novel feelings and reactions in a world ruled by the ever-present screen. A direct one-to-one communication, between an audience and a real human being who looks you straight in the eye and invites you to summon up your imagination so you don't miss the only story in the world

WEAVING MAGIC WITH THE SPOKEN WORD

The world according to Nicolás Buenaventura

Early on, Colombian storyteller Nicolás Buenaventura learned that "you have to invent the truth every day." With several storytellers in his family tree, he treats his gift with reverence and warmth of spirit

ASBEL LÓPEZ

UNESCO COURIER JOURNALIST

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Nicolás Buenaventura at home with storytellers in Mali.

After a few minutes of introduction, Nicolás Buenaventura realized that for the first time, he was before an audience that had grown up without listening to stories—street children who had never heard of *The Little Red Riding Hood*. It was midnight in Bogotá and the faces of these youngsters lit up. Once upon a time, people referred to them as street urchins, but as the country's situation deteriorated, they simply became billed as rejects.

So he decided to tell his version of how the world was created. "There was once a God who managed to resist the unfortunate temptation of making Man in his own image. First he created the Earth, and when he saw it was round and beautiful, he was left with lots of teeny tiny bits and pieces. Then he created time and when that started moving forward, he was left again with lots of teeny tiny bits and pieces." The children shouted and clapped as the storyteller rose to a higher emotional pitch to end his tale. "There's always a moment in life when you feel you don't belong in the world, and that's terrible. But if you know the story of Tom Thumb, you know that even the tiniest living thing has its place in the world."

Buenaventura found his own place in the world through storytelling. The boys in his neighbourhood were quick to discover his young talent. Because he did not have enough money to go to the cinema, they clubbed together to buy him a ticket so that he could tell them the film from A to Z afterwards. Today he makes a living from storytelling and dreams of directing his second feature film.

Like all his family, Nicolás was born with a storyteller's gift. His father Enrique is one of Colombia's leading playwrights and theatre directors. His grandfather Cornelio, a tireless conversationalist and professional storyteller, always repeated that "you have to invent the truth every day." So whenever he walked down the street, people would call out: "Hey, Cornelio, make up a little bit of truth for me, will you?"

Daily bread

But Nicolás did not get his enthusiasm for storytelling from them. His inspiration came from Fermín Ríos, a black storyteller from Colombia's main Pacific port of Buenaventura. "Fermín told me: 'I must tell you the story of the boy who lost his *bomboro* [a magical realist term that stands for any type of object], but he never did. The next year, he said: 'No, you're still not ready to hear it.'" Finally, he died and Nicolás had to go searching the world for the story himself. So far, he has found six versions of it—three in Colombia and three in Africa.

The Colombian ones form the story of the origin of the river Timbiqui. On a visit to Burkina Faso, he told the story in a village. "Because I was a storyteller, I wasn't seen as a foreigner. People realized I was bringing back stories they had given or lent to us centuries ago." Stories do not need a passport to travel, he says. All the world's people ask the same questions—why are we here, why do we have to die, what are we made of?—and the answers change from place to place. For ethnologists, these oral stories stand midway between question and answer.

After visiting three African countries, Nicolás understood how "telling a story is like putting bread on the table." This only enhanced his deep respect for all stories. Perhaps it explains why he staunchly opposes his stories being used for other purposes, such as by schools to encourage reading. Storytelling, he says, can't happen without an audience. There is no set ending in storytelling, and if there was one, it would be a story in itself. "Storytellers are the cups out of which people drink stories," he says.

Do stories change people? "In any case, they changed me. I'm more sensitive now to life's nuances." And do stories change the world? Nicolás replies by telling what happened to him one night in Bogotá as he was making his way home. "I was suddenly surrounded by some street kids and I thought 'I'm going to be robbed.' But no. Instead, I heard one of them shouting a familiar line at me: 'he was left with lots of teeny tiny bits and

Coming up with alternatives:the World Social Forum,held in Porto Alegre, Brazil,in January 2001.

Striking media giants with news on the Web

The Internet offers an unparalleled chance to spread an alternative to the news served up by the mainstream media, the "second power" of globalization, affirmed the World Social Forum in Porto Alegre

RENÉ LEFORT

DIRECTOR OF THE UNESCO COURIER

The organizers of the World Social Forum in Porto Alegre, Brazil,were expecting 2,000 people to attend a debate on "another possible world" in the last week of January. To their surprise, this "anti-Davos" attracted 5,000 fans. So how did the organizers of the forum, who like to cast themselves as visionaries, explain their all too modest forecast? Why, the Internet of course: they had set up a website one month before the Forum. Although very basic, it spurred much greater interest than anticipated.

The unexpected turnout was one more feather in the cap of the anti-globalization movement. Activists had already spent much time pleading for communication in general—and the Internet in particular—to be considered a leading "issue in the fight against neoliberalism." As such, it deserved the same attention as the campaign for the Tobin Tax, the cancellation of Third World debt or the control of world financial organizations. If not, they argued, cyberspace would become their adversaries' haven. According to the conclusions of a Forum workshop on communication and citizenship, the Internet has already been instrumental in shaping the economic and "ideological" revolution that has marked the process of globalization.

An ideological machine

Workshop participants launched a stinging indictment: "If the first power is economic and financial, the second belongs to the media," declared Ignacio Ramonet, director of the monthly *Le Monde Diplomatique,* upon opening the workshop. "It is the ideological machine of globalization." Participants asserted that mainstream news "is essentially transformed into a commodity…that does not obey any rule except that of the market. It is uniform, one-dimensional and based on a single source." Continuing the attack, Ramonet asserted that the mainstream media strikes a tone that is "emotional," "impressionistic," "sensationalist," "rhetorical," "simplistic" if not outright "infantile," and which is dominated by a quest for "immediacy." In short, "the supreme criteria" of media "mega-groups" is not truth but profit. "They're selling consumers to their advertisers."

The organizations attending Porto Alegre decided that it was high time to take on this "ideological apparatus," using the Internet as their chief weapon. One strategy involves criticizing the news produced by the "mega groups"—criticism that must not only be systematic, but should also be diffused as widely as possible. A leading example is FAIR, the best known media

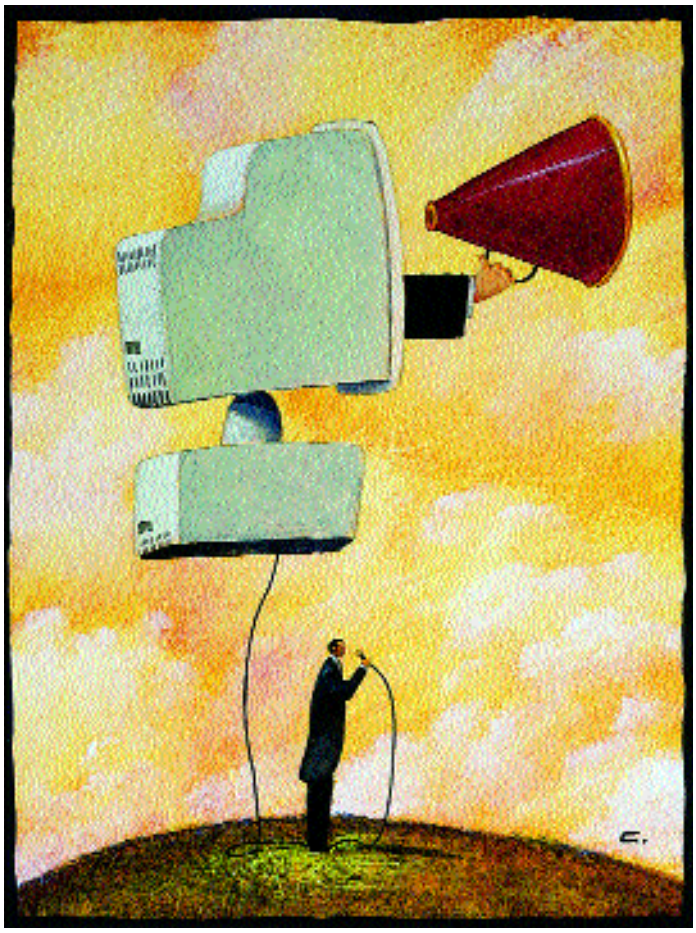
watchdog in North America. The organization aims to show how the structures of media conglomerates dictate content: the topics and viewpoints developed are those of an economic and political elite because these media belong to multinationals and are financed by others via advertising.

According to Seth Ackerman, one of FAIR's staff members, the Internet boasts three advantages over other forms of communication, including the group's magazine quarterly *Extra!*. First, it provides instant access to a wide range of alternative news sources, allowing the network to pick up on important matters ignored by North American mainstream media or to reveal a fine-tuned understanding of biased coverage. Secondly, FAIR can dispatch to-the-minute analyses at minimal cost to subscribers. Thirdly, it can involve subscribers in the organization's campaigns by encouraging them to email protest messages to media in FAIR's spotlight. "Thanks to the Internet, our activities made such a huge quantitative leap that they've also changed qualitatively," says Ackerman.

The second front that anti-globalization organizations are intent on opening is far more ambitious. The goal is to make the Internet the vehicle for a stream of "counter information" or "alternative information" aimed at a mass audience, far larger than the narrow circle of activists that all other mediums charged with the same purpose—the written press, radio and television—have managed to reach.

Diverse sources, grand ambitions

"What's really new about the Internet—and its chief asset—is that the entry ticket is infinitely more affordable than for any other more traditional media," says Jean-Pierre Marthoz[1] of Human Rights Watch. "The technical and political obstacles, such as getting around potential censorship, and above all the financial ones, in terms of investment and operating costs, bear no comparison with those faced by someone wishing to start up a newspaper or a radio or TV station. Internet opens the way for a diversity of voices that has been unheard of until now." Antonio Martins, head of the Brazilian edition of the *Monde Diplomatique*, adds that distribution channels are nearly unlimited on the web, whereas hertzian wavelengths have to be shared among a limited number of users.



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In short, the Internet radically changes the information on offer because it can harbour an unrivalled number of information sources. Given that one of the main criticisms of media conglomerates is their "single source" character, this makes the Internet all the more appealing says Henri Maler, of ACRIMED (Action-critique-médias),an NGO devoted to media monitoring. According to Maler, the rising costs of keeping a staff of journalists up and running means news is based on an increasingly narrow range of sources.

A first attempt at striking back was made last December in Bangalore, India, by some 30 journalists and writers. Their starting point was twofold: throughout the world, they stated, "discouraged" or "disillusioned"professional journalists want to restore some "nobility to their job, based on a social and democratic commitment." They can't do so, however, because employers stand in the way of publishing "articles that the public wants but never sees in print." Their goal is hence "to enrich the public information space… and create a critical mass of alternative information" through "articles in the written press and broadcast reports that can contribute to a socio-economic, cultural and political alternative" to globalization. The ambition is titanic: to launch a news service on the Internet that would sell its products and succeed in "becoming a counterweight to the mainstream media's stereotyped information." It would be "a complementary channel," rich in professionally packaged content.

Professionals or not?

To "communicate well, you need a range of skills," underlines Ramonet. "You can know the truth and have no impact because you don't know how to communicate. To think that the truth will naturally impose itself is to take an arrogant and contemptuous attitude towards citizens. The price of this is an absolute absence of communication." ▶

"A diversity of sources does not necessarily lead to an avalanche of quality information, something which only results from a thorough process of checking, selecting and setting in context to give meaning," says Marthoz. "The process still requires the hand of intermediaries who may not be journalists in the classical sense but 'para-journalists'." He points to his organization's site, which has become an almost indispensable source of information for anyone wanting to keep abreast of human rights in the world. Some 10,000 cybernauts visit the site each day, according to Marthoz, because the information placed online is collected by reliable experts and edited by seasoned experts in communication.

If this type of alternative service is anything to go by, audience rhymes with credibility, which in turn calls for some form of professional involvement. Not true, declares Roberto Savio of the Inter Press service, which has been serving up alternative news since 1964: this strategy risks running a lap behind current trends. Although IPS relies on a network of journalists in over 100 countries and counts more than 30,000 NGO subscribers on its online service, Savio, a pioneer of alternative news, is getting ready to step down and launch other ventures.

Civil society, he asserts, and youth in particular, reject outright all institutions or outfits functioning along vertical lines. It follows that the attempt to use the Internet as a carrier for a news counterweight while upholding the key position of the journalist—producing information from on high for the public below—is doomed to fail. It even rests on a deep contradiction, reproducing via Internet the same vertical model characteristic of all other media even though the web offers the chance to start a "communication society" operating horizontally.

The Brazilian model

Brazil's Rits (Information network for the third sector) is one such new communication network that believes the Internet's advent will allow the well-worn revolutionary slogan "of giving a voice to the people" to come true at last. "Let the people who live the story tell it," declares the network. For a start, you do away with the costs of financing a team of journalists. Red's associates—some 200 organizations from the "third sector" (neither public nor private)—exchange around 10,000 messages a week and express themselves without any supervision or editorial advice. The only protection is an ethical code that dictates what can be put on the site.

With or without professional intervention, whether raw or edited, can alternative news find its place in the limelight simply because it's alternative? Judging from present trends, Ramonet is mildly optimistic. "As the overall education level rises, that of the media is getting worse. There will come a time when the two will cross over: more and more groups and social categories are dissatisfied with the media's infantile discourse." While "nothing is won in advance, because we'll also have to be appealing, to win over hearts and souls," Martins insists that once a site is up and running, the Internet gives a chance to take on media conglomerates on equal terms, an impossible task in the print press or broadcasting. Marthoz, however, is more sceptical. "There's no reason for the Internet to escape the newstand effect. Just as the average reader first buys the most prominent publications at a newstand, the average cybernaut will first go to the best-known portals (Yahoo!, Google etc). But the latter select what information is posted, just like the gatekeepers of the traditional media. While Internet offers room for a large number of information producers, the tunnel effect is well and truly there on the receiving end."

"Nothing is won in advance because we'll also have to be appealing, to win over hearts and souls"

Marthoz also foresees another scenario. "Rather than think that the Internet will become an authentic information counterweight, its main effect will stem from how it influences the mainstream media. In this respect, there is no comparison with what the alternative print press or broadcasting can do. An alternative site can immediately be seen by the whole planet." Proof of this is how the world's press, including the most prestigious publications, consulted the Human Rights Watch site to keep up on the Chechnya war and even find "stories."

The force of the alternative

The "Internet mystique" does not convince ACRIMED's Maler "Making the web's immense democratic potential a reality does not depend chiefly on the tool itself," he says. "The space given by the public to alternative news, as opposed to commodified news, will be a reflection of the alternative forces carrying it." In other words, between the Internet and anti-globalization activists, who's the chicken and who's the egg? ■

1. *Jean-Pierre Marthoz, European news director of Human Rights Watch and author of* Et maintenant le monde en bref *("And now the world in brief"), Editions Complexes, Brussels, 1999, and contributor to* Human rights and the Internet, *Orbicom/UNESCO, 1998, as well as the UNESCO World Communciation Report 2000.*

+ ...

The organizers of the World Social Forum created a site at www.forumsocialmundial.org/br; comprehensive reports on the event can be found on the s<æÂite of the Latin American Information Agency, at www.alainet.org. For more information on FAIR, see www.fair.org
Other sites æÂthat keep a close watch on the mainstream media include Media Channel (www.mediachannel.org) and ACRIMED for the Francophone media (www.samizdat.net/acrimed/).
The Human Rights Watch site is at: www.hrw.org
Although the participants of the Bangalore meeting have not set up a site yet, major alternative general news sites include One Word (www.oneworld.net) and Indymedia (www.indymedia.org).
For the Inter Press Service, see www.ips.org and for the Rede de informaçóes para o tercero sector: www.rits.org/br

Mark Anspach

Global markets, anonymous victims

In the great metropolises of market society, hundreds of homeless people die each year.
We don't even know their names. For the American anthropologist Mark Anspach[1], the market economy has not succeeded in ridding us of sacrifice. And yet, its rationality was supposed to distance us from ritual violence and those who practice it

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Wearing death masks, workers protest a factory closure in eastern France.

You study exchange in primitive societies as well as in market society. Do transactions everywhere match the description of economists?

No. The economists' myth tells us that exchange fulfills a simple instrumental function. You live in a community that produces yams and I live in a community that raises pigs, so we enter into an exchange in order to vary our diets. One fine day, to facilitate our transactions, we invent a system of equivalence between our products—money—and there you have it. But, as anthropologists have shown us, Marcel Mauss in particular, the main form of exchange in so-called "primitive" societies is the gift, which cannot be reduced to economic rationality.

You mean to say that people did not invent exchange in order to satisfy their material needs?

In "primitive" societies, families may be quite capable of producing what is necessary for their subsistence. And yet, they will still enter into exchanges. Why? For the sake of exchanging—of forging relations with others and participating in the circle of positive reciprocity on which social life is founded. To refuse to exchange, to keep what one has for oneself, amounts to a kind of incestuous indulgence, as Claude Lévi-Strauss observes. He quotes a proverb from New Guinea that makes this point: "Your own mother, your own sister, your own pigs, your own yams, you may not eat. Those of other people, you may eat." If you eat your own yams, your neighbour is liable to think they're better than his, and your relationship could turn acrimonious.

Even if my yams are just like his?

Even then, there could arise what the thinker René Girard (see inset) calls a mimetic rivalry, based on reciprocal imitation. The neighbour who sees you feasting on your yams will want to do the same as you, that is,

1. *Mark Anspach studied at Harvard and Stanford. He obtained a doctorate in anthropology from the Ecole des hautes études en sciences sociales in Paris. He is a research scholar at the CREA (Centre for research into applied epistemology), Ecole Polytechnique. His book,* "A charge de revanche, les formes élémentaires de la

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"We continue to **persecute** victims but are now **ashamed** to do so: that is progress"

he will want to eat your yams. What seems to be desirable to you becomes desirable for him. But if he tries to appropriate your yams for himself, you won't want to surrender them. What is desirable for him becomes equally desirable for you. In this manner people can easily come to blows over nothing. Ritual prohibitions serve to prevent rivalries of this kind. The incest taboo, for example, keeps men from fighting for the women who are closest at hand, those who belong to the same family. A crime of passion could trigger a general crisis. It is hard for us to conceive just how dangerous the slightest dispute can be in a community with no police or judicial system. As with a hemophiliac, any bloodshed could prove fatal. If you kill your neighbour when he tries to grab your yams, his relatives will come after you next. Each act of violence must be avenged by a new act of violence, and the ensuing chain reaction can ultimately engulf the entire community.

Doesn't this approach betray the belief that human beings are fundamentally violent?

People are not fundamentally violent, they are fundamentally social. Once they have satisfied their material instincts—eating and reproducing—they still sense a lack. They desire something more, but what? Since Freud, we assume that desire is the most individual, most intimate thing there is about a person. For René Girard, this is a romantic myth. On the contrary, people do not know what to desire, it is something they must learn. And they learn it in the same way they learn all the essential things in life: by observing and imitating others. Humans are incomplete beings who are born radically dependent on others. It is no wonder they show themselves to be fascinated by others. But it is precisely people's fascination with each other which brings them so easily into conflict, and can sometimes embroil them in the worst forms of violence.

All your explanations presuppose a universal human nature.

I believe one should stand firm on this point: yes, there is a universal human nature. That does not mean that people everywhere are identical. Since people do not know instinctively what they want to do in life, their culture must offer them answers. Obviously, the range of answers varies from one culture to another. It is not such and such a model of behaviour that is universal, it is the need to have models. If people do not know what to desire, if each person tends to desire what others desire, the culture must channel desires in such a way that they do not constantly converge on the same objects. It must defuse the vicious circle of reciprocal desire, where each wants what the other wants, or risk descending into reciprocal violence. The paradoxical law of revenge commands the killing of the killer. And the killer's killer? Here one falls into a new vicious circle.

And is there any way out?

What interests me is precisely to see how the shift is made from vicious circles to virtuous ones, from the negative reciprocity of violence to the positive reciprocity of the gift. With vengeance, each person responds to an offence committed by the other, each reacts to what the other has already done. This comes down to letting oneself be dominated by the past. In gift exchange, on the other hand, one turns toward the future and anticipates the desire of the other. Instead of waiting for your neighbour to come steal your yams, you offer them to him today, and it is up to him to do the same for you tomorrow. Once you have made

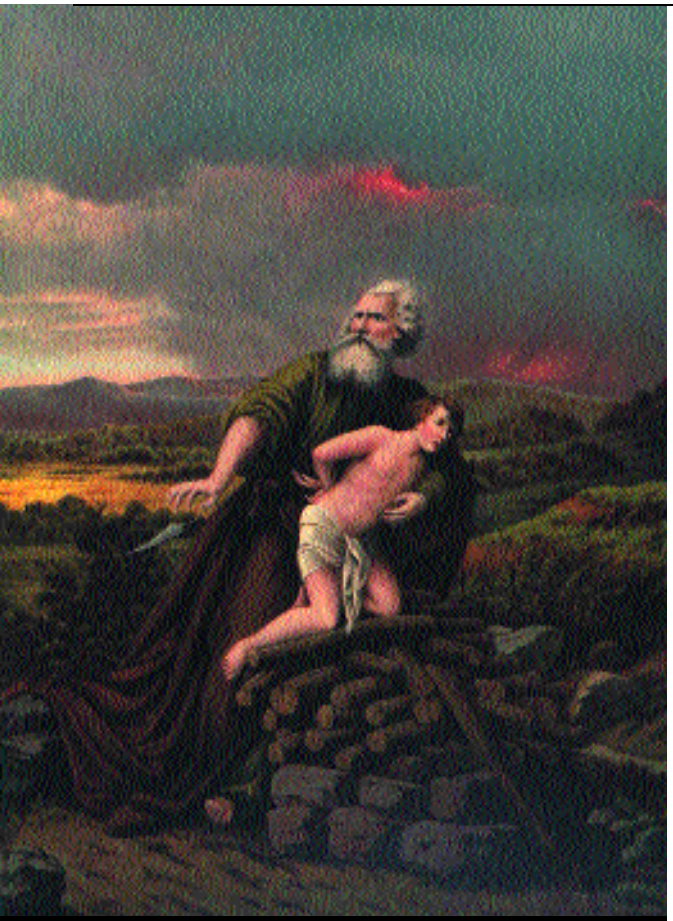
ON GIVING, TRADING AND RITUAL SACRIFICE

Adam Smith (1723-1790) recommended giving free rein to individual rivalries with the idea that their combination produced order. To describe this phenomenon, he invented the metaphor of the "invisible hand of the market."

Marcel Mauss (1872-1950) described, in The Gift, the systems of ritual exchange among native Americans or Melanesians. For him, the gift is a "total social fact," at once religious, economic, political, matrimonial, legal.... Today, the Mouvement anti-utilitariste dans les sciences sociales (MAUSS) lays claim to his heritage and criticizes economic reductionism(www.revuedumauss.com).

In The Elementary Structures of Kinship, **Claude Lévi-Strauss** analyzes marriage as a form of reciprocity between kin groups, but he does not explain its origin (see Lucien Scubla, Lire Lévi-Strauss, Odile Jacob, 1998).

René Girard has taught in the United States since 1947. His writings take us back to the violent origins of exchange. In all human relationships, he discerns the mechanism of mimetic rivalry, set forth in his first major work, Deceit, Desire and the Novel. We desire only what others desire. When this contagious rivalry seizes hold of a whole community, it is not appeased until the "all against all" is transformed into an "all against one." One antagonist is killed and peace returns. The victim then appears all-powerful since he or she was able to restore order. His following book, Violence and the Sacred, shows how the sacred arises out of sacrifice. In The Scapegoat, he develops the idea that the Christian scriptures inaugurated a long process of questioning this founding violence. Latest book: I Saw Satan Falling Like Lightning (Orbis, in press). The journal Contagion publishes the work of "Girardian" scholars (http://theol.uibk.ac.at.cover.index.html).



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Abraham and Isaac:the birth of an "anti-sacrificial"consciousness.

a gift, he is obliged to make a return gift. Now you have set in motion a positive circularity.

One which makes it possible to escape the circle of violence?

Yes, but through one last act of violence. By killing a "sacrificeable" victim, meaning one whose death will not trigger further acts of vengeance within the group: a slave, an imprisoned enemy, an animal.... In a peace ritual described by anthropologist Raymond Jamous, the murderer leads his people to the territory of his victim. His hands bound and a knife in his teeth, he offers himself as a new victim, he anticipates the desire for revenge of his adversaries. But rather than killing the murderer as they would if the cycle of vengeance were to continue, they take the knife and sacrifice an animal in his stead. To seal the end of hostilities, the members of both camps join together in eating the animal. Not only will this victim not be avenged, but it provides the feast which launches a new cycle of positive reciprocity. The rite which puts an end to a vendetta facilitates the transition between the reciprocal violence of vengeance and the non-violent reci- procity of the gift.

But how does market exchange come to take the place of the gift?

First let's see what distinguishes them. When you offer me so many sheep, or shells, or shields, you make a display of your prestige, and I must at least match your generosity with a return gift. On the contrary, a monetary payment nips the relationship in the bud: it relieves one of any return obligation. A market transaction leaves the seller and buyer free of any ties. Just as the gift breaks the circle of vengeance, money breaks the circle of the gift. I asked myself how such a transaction could arise within a ritual context. In Vedic writings from ancient India, we see that monetary payment begins with the compensation of the sacrificial priest, a *brahman* who carries out a dangerous task and whom one prefers to keep at arm's length. In the Greek world, money is associated with the figure of the tyrant. He is a usurper, a king whose legitimacy does not derive from traditional structures. To get around the system of reciprocal obligations which he challenges, he must resort to employing mercenaries, whom he pays off with money. War, a ritual activity, becomes a professional one. In our monetary economies, all transactions involve this distancing mechanism which originally targeted those charged with carrying out ritual ▶

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"If your neighbour is **hungry**, you have **no obligation** to feed him"

violence.

So you trace market exchange back to sacrificial rituals?

In these examples we already see the beginning of an impulse to thrust away the operators of sacrifice. Later, sacrifice itself will be banished. All our history is a long process of awakening an anti-sacrificial consciousness. First,an animal replaces the human victim, as in the story of Abraham and Isaac. Then the day comes when people hesitate even to butcher the animal. René Girard attributes the origin of this awakening of consciousness to the Biblical texts, the Gospels in particular. One may also find anti-sacrificial messages in other traditions, in Buddhism for example. But one does not have to be Christian to acknowledge the force of René Girard's analyses, or to follow him in reflecting on where the decay of religious myths and rituals may lead.If sacrificial rites, while producing victims, made it possible to avoid even greater violence, what will happen in the absence of rites? We know that human progress has always been fragile, with steps backward accompanying every step forward. I believe it is important, nevertheless, to defend the notion of progress. Even if we continue to persecute victims, we are now ashamed to do so:that is progress.

We have learned to recognize the victims. But our morality adapts quite well to the market economy, which also produces victims of another sort.

Monetary transactions sever the bond between exchange partners; they eliminate all obligations of reciprocity. If your neighbour is hungry, you have no obligation to feed him; if he is evicted from his home and freezes to death, you have no obligation to avenge him. As Canadian philosopher Paul Dumouchel observes, the elimination of the obligation of revenge keeps violence from spreading from one individual to the next,but at the same time it universalizes the category of "sacrificeable" victims, those whose death will not result in vengeance. In this sense, we continue to sacrifice anonymous victims. In his book *Le sacrifice et l'envie* ("Sacrifice and Envy"), French philosopher Jean-Pierre Dupuy shows the extent to which the spectre of sacrifice haunts the thinking of the major theorists of the market economy.

Why not set ourselves the objective of returning to the gift?

We have not completely left it, fortunately. Gifts, including services within the household, still hold an important place. In France, by the conservative estimate of one economist, Ahmet Insel, gifts are of a magnitude equivalent to about three-quarters of GDP. We should aim for a balance between the gift sector and the market sector. But this balance is threatened today by the imperialism of market logic. It is that logic therefore which must be questioned. Obviously, we will not go back to archaic forms of exchange. These presuppose a ritual framework which has vanished. A new religion cannot be made to order.

But hasn't the market economy taken the place of religion?

The ritual framework of primitive exchanges entails the presence of invisible mediators. The spirit of the

gift obliges the recipient to make a return gift, Marcel Mauss tells us. Adam Smith, the father of liberal political economy, likewise invokes a hidden spirit when he talks about the invisible hand of the market. Of course, he means this as a simple metaphor: the market is supposed to be self-regulating, functioning best without visible intervention on the part of the State. But nothing guarantees that, left to itself, the market will converge on a satisfactory equilibrium. History tends rather to prove the opposite. In this sense, the doctrine of the invisible hand does depend on quasi-religious faith. It serves mainly to absolve people of the consequences of their actions.

When a jumbo jet falls to the ground, there is an investigation to determine who is responsible. But every day, the number of people who die of hunger in the world is equivalent to the number who would perish if several hundred jumbo jets crashed. No investigation is needed: the market is responsible. Which is another way of saying nobody. Nobody is individually responsible for a violence which is collectively accepted, just as the violence of sacrifice is collectively accepted.

The opponents of market globalization advocate the establishment of "fair trade." Isn't this a contradiction in terms, if the market is by nature irresponsible?

Why not develop fair trade? In reality, the partisans of market globalization claim that they themselves want to promote the interests of poor workers. This is a good illustration of the ethical progress we were talking about: everybody recognizes the central importance of the victims. But the alibi is pretty flimsy because poor workers are perfectly able to determine what is in their own interest. Their union representatives could organize an international summit to negotiate a fair framework for trade themselves—at Davos, for example. Just as war is too serious a matter to be left to the generals, trade is too serious to be left to the captains of finance.

Montesquieu said that the natural effect of trade is to lead to peace. Your analyses do not seem to confirm this adage.

Globalization means the development of market exchange among nations. Now, despite the existence of the United Nations, the international arena still displays one of the essential features of primitive society: the absence of the State. In true primitive societies, where gift exchange predominates, one sometimes finds transactions quite similar to market exchange. These transactions are practiced solely with foreigners towards whom no duty of solidarity exists. With them, one has the right to cheat, steal, or wage war. Lévi-Strauss alludes to markets of this type where buyers and sellers are ready to fight at the slightest provocation and goods are offered at spear-point. That reminds me of a *New York Times* journalist, an advocate of globalization, who explained that the invisible hand of the market must be accompanied by an iron fist. I am skeptical about the idea that an expansion of international trade leads to peace. The same idea was expressed the last time a comparable level of economic integration between countries was reached, early in the last century.

And?

And then the First World War came along and dispelled this illusion.

INTERVIEW BY YANNICK BLANC AND MICHEL BESSIÈRES

RESPECTIVELY WRITER AND UNESCO COURIER JOURNALIST

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