CIFAR

CANADIAN INSTITUTE
for ADVANCED RESEARCH

Annual Report 07-08

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See far, go further.

OVERVIEW

The Canadian Institute for Advanced Research incubates ideas that revolutionize the international research community and change the lives of people all over the world. Through its research programs, CIFAR provides leading scholars with the time, direction, freedom and inspiration to pursue fundamental questions concerning society, technology, and the very nature of humanity and the universe.

CIFAR empowers the world's most gifted thinkers to collaborate on groundbreaking, provocative projects and ensures that Canada remain a global leader in advanced research through its international scope.

Through regular program meetings CIFAR brings together researchers from different countries, institutions, disciplines and levels of experience. These meetings help to foster new connections, ideas, and long-term relationships that lead to avenues of research whose influence extends far beyond the CIFAR community to the broader research world. CIFAR's cooperative, interdisciplinary approach means that program members delve into issues that no conventional university or research institution could address.

VISION

The Canadian Institute for Advanced Research aspires to be the world's preeminent collaborative advanced research organization.

MISSION

In order to enrich human knowledge and improve society, CIFAR strives to be a leader of the global research agenda for increasingly complex questions. To this end, it sets its own research agenda, and develops and employs innovative research models in order to expand the frontiers of knowledge and understanding.

The organization sees itself as an icon of intellectual excellence. It brings teams of elite scholars from around the world together in a potent environment that inspires trust, boldness of ideas, and a unique spirit of deep collaboration. CIFAR supports researchers as they take whatever academic risks are necessary to pursue advanced research subjects of global importance.

CIFAR is both intensely Canadian and intensely international, and is committed to building and sustaining an exciting intellectual community that connects Canada's researchers with their peers around the world.

KEEP ON RESEARCHIN'

The answers to big questions always seem to lead to even bigger questions. This increasing complexity is reflected in how CIFAR has grown. During the Institute's first 25 years, our world has only grown more complicated, fast-paced and multi-faceted. CIFAR now has more researchers and more research programs than ever before – and the questions just keep coming.

Floods of new data – in genomics, economics, astrophysics and more – open up new frontiers, and empower researchers to make sense of subject areas that were not long ago simply too complicated to contemplate meaningfully.

I am proud to present to you our Annual Report for this year, which should give you some sense of how CIFAR is leading the world into so many fertile areas of intellectual exploration. I hope that your imagination is captured by the possibilities inherent in these research programs. The highlights from our past year provide a glimpse of the incredible future these researchers are helping to create.

It is never wise to try to predict the future. I will not even hazard a guess about when we will have the first practical quantum computer, or thousand-dollar genome, or room-temperature superconductor, or any of the other innovations that come closer to reality with each passing year of CIFAR research. But I will predict that each discovery, each advance, each answer, will inevitably lead to new, even more complicated, and even more fascinating questions. And, I predict that CIFAR will be there to assemble intellectual leaders from Canada and around the world to meet these new challenges.

The need and the opportunities for collaborative advanced research will only grow in years to come. And we will, indeed, keep on researching.

Richard W. Ivey

CHAIR OF THE BOARD OF DIRECTORS
CANADIAN INSTITUTE FOR ADVANCED RESEARCH

GREAT MINDS THINK DIFFERENTLY

I would like to congratulate and thank all CIFAR researchers, staff, donors and other supporters on making the Institute's 25th fiscal year one of the most surprising and successful ever. You have pushed this organization to new heights, and given all of us exciting new ideas to talk about.

When we say that great minds think differently, it means many things. It is an appreciation of those few visionaries whose intellect takes them beyond established rules and limitations to make discoveries that change the way we understand our world, our universe and ourselves. We are lucky to count many such individuals within CIFAR's community. It is also a reference to the fundamental idea that complex questions require multiple perspectives, and that it is only through collaboration that many research questions will be answered.

Let it not be lost in that sentiment, though, that as diverse and eclectic as are the many people connected to CIFAR, we are all united in the goal of expanding the frontiers of human knowledge. As you will read in this report, we are exploring more of these frontiers in more ways than ever before.

The stories in this publication give only a small taste of all of the work being done by CIFAR researchers in laboratories, offices, and exotic field locations all over the world. I hope they whet your appetite, and inspire you to get more involved with CIFAR's events, debates and discussions.

The second half of this report shows how this was also a very successful fundraising year for the Institute. This of course makes us optimistic about our plans to expand our support of advanced research in the coming years. I am also delighted to note that we have more donors than ever to thank. That's a sign that more people than ever believe in this organization, and recognize the value of advanced research to Canada and the world. CIFAR succeeds because it is based in a country with so many great minds.

Our research, our fundraising efforts, and our place in the public consciousness all continue to grow. I am proud of what this organization has accomplished, and I know that it is a sign of even greater things to come.

Chaviva M. Hošek, O.C.

LAWSON FOUNDATION FELLOW
PRESIDENT AND CEO
CANADIAN INSTITUTE FOR ADVANCED RESEARCH

CIFAR, GO FURTHER

CIFAR prides itself on being an unusual organization. And yet, in some ways, it is not as different as you might think. Like many other international not-for-profit organizations, CIFAR's ultimate aim is to enrich humanity in the broadest sense. I think it's fair to say that the way we work toward this goal is unlike any other organization on the planet, but we, like so many others, strive to be a force for good.

I am proud of the unusual role we play: We work with researchers who are at the very top of their fields. We support advanced research whose impact on day-to-day life might not be apparent for years (though when that effect does hit, it is transformative). We cultivate multidisciplinary teams whose work – as you can learn from reading this report – is both mind-boggling and inspiring. And the knowledge we create helps inform scientific and social decisions that are the foundation of human progress.

There are many reasons why we decided to create a "T-shirt edition" of our annual report, not least because we thought it would be fun. Fun for us, and I hope fun for you. It's also a reminder, though, that while we might not be a typical not-for-profit, we still depend on our donors and supporters to enable us to do our good work. I hope that our play on T-shirts – an iconic staple of the fundraising world – will serve as a reminder of this fact.

If you are already a CIFAR donor, I give you my most sincere thanks on behalf of the Institute. And if you are not yet a donor, please consider helping us to make the world a better – and more interesting – place.

George A. Fierheller

CHAIR ADVANCEMENT AND
COMMUNICATIONS COMMITTEE
CANADIAN INSTITUTE FOR ADVANCED RESEARCH

"Dark Matter is the New Black"

Modeled by Jen McNeely, fashion guru and star watcher.

COSMOLOGY AND GRAVITY

By Dick Bond, Program Director

CIFAR researchers have helped show that stars, planets, galaxies, and the gas and dust in between them – the stuff that we can directly see – make up only about 4 per cent of the total mass of the Universe.

Another component, invisible to traditional detection methods, is the dark matter that holds galaxies together and keeps stars from flying off into intergalactic space. This dark matter accounts for about 22 per cent of total universal mass. Our main information comes from the first light of the universe, called the Cosmic Microwave Background (CMB), which was released from ordinary matter when the Universe was a mere 380,000 years old.

Highly anticipated results were announced this year from four CMB experiments, three with heavy CIFAR involvement. These experiments solidified and improved the accuracy of our measurements of matter and dark matter. More important, they refined our "accelerated expansion" theory of the Universe. CIFAR members are already pursuing the next generation of experiments to achieve even higher precision.

Many important experiments involve CIFAR members: They use optical telescopes to observe the "gravitational lensing" of distant galaxies by dark matter, which distorts images of the galaxy. More great results have come from the Canada-France-Hawaii Telescope and the Hubble Space Telescope. Now there is an all-out effort to make much larger surveys to build on these successes. For example, many of CIFAR's international associates are involved in the Panstarrs telescope project (led by Associate Nick Kaiser), and with proposals for a space mission. Two more experiments have confirmed lensing of the CMB itself.

We are on our way to determining how dark matter clusters in intergalactic space, in galaxies, and in clusters of galaxies. But none of this explains what it is. Our best bet is that it is a relic released from ultra-hot matter in the first nanosecond of the Big Bang and our hope is that we can detect it directly. It may annihilate in the centre of galaxies, creating detectable radiation.

New international experiments will happen in an ultra-deep mine at the uniquely Canadian Sudbury Neutrino Observatory. The SNO lab is the best place on Earth to search for dark matter. These experiments, involving CIFAR Fellow Mark Chen, use the Laurentian Shield to filter out debris from collisions of high energy cosmic rays, which would otherwise obscure faint indicators of dark matter. We hope the Large Hadron Collider, the world's largest atom smasher at the CERN facility in Geneva, may also detect these dark matter particles. So we may be on the verge of direct dark matter detection by any of three paths. We are fully engaged in two, and have plans for the third.

Another frontier area for us is in the densest stuff in the universe: black holes and neutron stars. Program members have been observing rapidly spinning neutron stars, theorizing about matter and energy in these extreme gravitational environments.

Their tremendous gravity can merge nearby black holes and neutron stars together. Understanding what happens during such mergers is no small task since our concept of space and time breaks down at this point. Despite the challenges, program members have made incredible progress in computing gravitational radiation – ripples in spacetime that propagate away from such catastrophic events. We hope to detect these waves, thereby revealing the heart of strong gravity.

CIFAR members continue to be well prized nationally and internationally, with new fellowships this year in the Royal Societies of London and Canada, the National Academy of Sciences, and NSERC. For me it has been an exceptional year, the Order of Ontario and the Gruber Foundation's 2008 Cosmology Prize – the most prestigious award in the field. At the ceremony, I praised CIFAR and its wonderful network structure, developing a web of researchers around the world, with a very strong Canadian base. It has been crucial for supporting me and connecting me to the best in the world. By providing tangible data and reliable theories about the cosmos, CIFAR's *Cosmology and Gravity* brings the world of the invisible into the world of understanding.

"90% Microbial, 10% Human"

Modeled by Naveen Rana, accountant and complex ecosystem.

INTEGRATED MICROBIAL BIODIVERSITY

By Patrick Keeling, Program Director

The human body is an ecosystem – it is home to about 100 trillion microbes, which live and work in skin, hair, mouths and intestines. We give these organisms a home, and in return, they help us do everything from digest food to fight off illness.

The planet is a palette of many different ecosystems, whose plants, animals and microbes create, preserve and use healthy environments. These ecosystems, whether aquatic or terrestrial, natural or man-made, are shaped by microbial activity.

Microbes are among the most influential components of any ecosystem; they break down organic waste, help plants grow, and remove almost half the carbon dioxide and other greenhouse gases from the atmosphere. They thrive in greater numbers, greater volume and greater diversity, than all other living things combined.

But despite their ubiquity and their key role in maintaining a healthy planet, we know virtually nothing about microbes.

In its second year, the *Integrated Microbial Biodiversity* program pooled its microbial expertise to investigate many dimensions of our planet's ecosystems. This integrated research reveals a deeper picture of the diversity within different environments.

Saanich Inlet is one such environment. Located just north of Victoria, BC, this area is a "dead zone": a marine environment that contains low levels of oxygen. Steve Hallam has worked at Saanich Inlet for years. He recently discovered that archaea, a group of single-celled organisms that have no nucleus, are now dominant in that area. This finding implies that in the absence of oxygen, archaea are able to survive by eating nitrate (the next best nutrient available). Although it is toxic to many other organisms at high levels, nitrate may actually be a natural food choice for archaea. Steve is working to understand this phenomenon.

Dr. Hallam is also collaborating with fellow program members Forest Rohwer and Curtis Suttle to uncover what other microbes, including viruses, live in the inlet. To achieve this, the researchers perform a metagenomic analysis, which uses genetics to investigate an intact microbial population.

Dr. Rohwer is actually a metagenomic pioneer. This year, his research group published the first comprehensive analysis of the metabolic processes occurring in microbial and viral communities in several major ecosystems. Their analysis revealed that the viral communities serve as a repository for storing and sharing genes, and thereby influence global evolutionary and metabolic processes.

Program members also attempt to identify new biochemical processes and life forms. Alastair Simpson has discovered and characterized several new species of anaerobes, organisms that can grow and survive without oxygen. His research team uses these organisms to better understand how organelles, the subunits inside cells that have specialized functions, degenerate. In the same vein, Program Member Brian Leander uses the new marine and deep-sea microbe species (discovered by his group) to trace how parasites and endosymbionts (organisms that live within the body or cells of other organisms) evolve.

Integrated Microbial Biodiversity program members are also organizing and attending specialized workshops. Most recently, Dr. Suttle organized a symposium in Vancouver on aquatic viruses and Drs. Keeling, Leander, and Simpson organized a large workshop in Halifax to contribute to the Tree of Life Web Project.

This project is a massive, publicly accessible repository for all scientific knowledge about the diversity, evolutionary history and characteristics of every species and significant group of organisms on Earth, living and extinct. This incredible wealth of information, contributed by an unprecedented alliance of world experts, is designed to create a grand understanding of all life on the planet.

The Halifax workshop attracted microbial experts from Japan, Russia, Switzerland, Germany, France, the Czech Republic, the U.K., the U.S., and Canada. The workshop garnered mainstream media coverage, including an opinion piece by Program Member John Archibald entitled "Look on the bright side of microbial life", which was published in the Halifax *Chronicle Herald*. The piece conveys a crucial message of the *Integrated Microbial Biodiversity* program: Instead of viewing microbes as the enemy, we should respect the many vital roles that they play in our lives and the need to understand them better.

"He Got Game Theory"

Modeled by Clifton Brown, Muay Thai boxing champion and athletic institution.

INSTITUTIONS, ORGANIZATIONS AND GROWTH

By Elhanan Helpman, Program Director

Since its inception in 2004, the *Institutions, Organizations and Growth* program has been singularly successful in addressing key questions about economic development, prosperity and poverty – questions which continue to preoccupy a diverse group of institutions and individuals on the global stage from the World Bank to the rock star Bono.

One particularly vivid illustration of the impact of the program was a special public event in Ottawa in October 2007 built around the question "Why are some countries rich and others poor?" (This was part of CIFAR's cross-country event series, *The Next Big Question*.) Members addressed the question through a series of lectures and the event elicited an unprecedented level of interest and enthusiasm among high-profile policy makers, politicians and business leaders.

In the course of our work, members also meet with representatives of the World Bank, the International Monetary Fund and the Organization for Economic Co-operation and Development. What we find, without exception, is that people in all these communities are hungry for new ideas, new insights and very much want to understand new research findings of the group. In some cases, the program's findings are incorporated into policies and objectives. The World Bank, for example, has embraced the importance of institutional reforms, from improving public service delivery to legal reform, as a major policy issue.

Over the past year, numerous research papers contributed to our growing understanding of economic and political institutions and organizations. For example, James Fearon and David Laitin developed a model showing how, when various factions are constructing power-sharing arrangements in central and regional governments, issues of commitment tend to lead to "all or nothing" fights for control.

Timothy Besley and Torsten Persson, together with Daniel Strum, employed a combination of theory, history and econometrics, in order to study the effects of political competition on economic policy formation and economic performance. The theory illustrates how single-party dominance may depress economic development by fostering a party machine. This machine pursues economic policies which, in turn, appeal to the vested interests of a small elite rather than the interests of the population at large.

2008 will see the publication of *Institutions and Economic Performance*, a collection of 13 essays which I had the opportunity to co-edit. The essays highlight much of the collaborative work of program members and examine the link between how companies organize and innovate and how this process shapes the industrial structure. They also explore the question of why income per capita varies so greatly across countries – even when taking into account obvious disparities.

As in previous years, members of the program were awarded numerous honours. Special mention must go to Advisory Committee Member Roger Myerson, one of three winners of the 2007 Nobel Memorial Prize in Economic Sciences. Dr. Myerson was recognized for his contributions to mechanism design theory.

In 2007/2008, we added two scholars to the program: Gustavo Bobonis, an economist from the University of Toronto, and Benjamin Nyblade, a political scientist from University of British Columbia. These appointments add to our critical mass of young scholars from across the country and help position Canada as a leader in this specialized area of study.

As the program enters its fifth year, it is clear that members, together with other social scientists, have made considerable progress in documenting the role of political and economic institutions (using broad and non-traditional definitions) in economic growth. Members have developed analytical frameworks to assess how institutions and organizations influence economic outcomes and have used these frameworks to interpret the evidence. Game theory, for example, focuses on how individuals within a group interact and the net outcome of those interactions across the population of the group. Indeed, the large body of research produced by members has contributed, in a major way, to a new and profound understanding of institutions and organizations not as static entities but as dynamic forces with the power and potential to affect citizens, communities and development around the world.

"If we don't stop global warming, humanity might not survive to see the next ice age."

Modeled by Bettina Share, publicist and spreader of the warmth.

EARTH SYSTEM EVOLUTION

By Jerry X. Mitrovica, Program Director

Humankind is emerging as a dominant source of change in the Earth system. This change threatens to perturb the dynamic equilibrium and stability of the environment for life on Earth, including the life support system upon which humans depend for their well-being and survival.

Many Earth scientists focus exclusively on the modern record of climate change. In contrast, scientists in CIFAR's *Earth System Evolution* program put the current issue of climate change in the much larger context of the billions of years of our planet's history and future. One of the curious things this context tells us about our current situation, for instance, is this: However pressing the issue of global warming is today, it is unlikely to change the fact that the Earth will experience another ice age thousands of years from now. This information should not be interpreted as diminishing our current crisis – in fact, we hope that this long-term context will help us better understand how to deal with our current situation.

CIFAR's *Earth System Evolution* program aims to evaluate society's true potential to significantly alter the global environment. Our research is driven by the philosophy that the Earth's history is a guide to forecasting the Earth's future: By working together to interpret the geologic record and better understand how the Earth functions today as a self-regulating system, we can successfully project the geological changes to come.

One recent focus of the group is identifying mechanisms responsible for many of the interesting topographical features of the Earth. Textbooks argue that these sea-level variations reflect changes in the rate at which tectonic plates are created at the surface. As this rate increases, water levels rise and continents become flooded; as the rate decreases, water levels fall and shorelines migrate outward. Our program has rewritten this chapter of the textbook: Program Member David Rowley has shown that the rate of plate creation has actually been steady for the last 80 million years. Postdoctoral fellow Robert Moucha and Dr. Rowley, and Program Member Alessandro Forte and myself, have used simulations to demonstrate that long-term sea-level changes are strongly influenced by vertical motions of continents, or dynamic topography. These simulations have also helped to solve two other longstanding enigmas – the recent uplift of the Colorado Plateau, and the onset of large earthquakes that are well away from plate tectonic boundaries.

Another area of focus within the group is wildfires, which are a known outcome of climate change and events such as meteorite impacts. Program Member Peter Reiners developed innovative methods for recognizing the effects of wildfires in the geologic record. Now, CIFAR postdoctoral fellow Abir Biswas is working with Dr. Reiners and his fellow program member Lee Kump to extend these methods, and determine the frequency and intensity of ancient wildfire events, and how they relate to other phenomena, such as climate change.

Program Member Mark Jellinek studies plate tectonics as well, but is motivated by a desire to better understand the differences between the Earth and other terrestrial planets, such as Venus, Mercury and Mars. This research is poised to help determine the possible conditions that could exist on Earth-like planets beyond the solar system. He and his collaborators recently showed that when the atmosphere is heated for a prolonged period of time, plate tectonics can shut down, causing a planet's crust to become locked in place. This locking of the Earth's plates could result in increased volcanic activity. Venus provides evidence for this possibility: It shows no outward signs of tectonic activity and has an extremely hot, bone dry surface littered with many volcanoes.

The planetary theme is a new direction for the group; it arises from the evolving research interests of many long-term members and core research by several new members. Our aim is to explore the planets of the solar system and extrasolar planets for new knowledge that can be used to further improve our understanding of Earth's evolution and future.

"I'm with nature," and "I'm with nurture"

Modeled by Jenna and Robyn: same genes, different people.

EXPERIENCE-BASED BRAIN AND BIOLOGICAL DEVELOPMENT

By Ron Barr, Program Director,
and Bryan Kolb, Associate Program Director

Which contributes more to the area of a rectangle, its length or its width?

For members of *Experience-Based Brain and Biological Development*, this question makes about as much sense as: Which contributes more to personality, nature or nurture?

Examining nature and nurture as separate entities is futile. We study the two together, because neither has meaning without the other.

Our program researches the entangled effects of genes and environment. We contest the traditional idea that you are given a set of genes when you are born that ineluctably determine everything from your nose shape to your learning abilities. You are not as limited by your DNA as it used to appear. Because genes can be turned on and off, no concrete destiny is written in your genome.

Our program investigates how social experiences get under the skin to affect gene expression, thereby influencing early trajectories for lifetime development and health.

Several researchers use an epigenetic approach to answer this question: They study how environmental factors affect the way genes are expressed, even though the genetic sequence itself does not change.

Many of these projects are inspired by the work of Program Members Michael Meaney and Moshe Szyf, who have revolutionized this area of research. Some of their discoveries came from studying early caregiving differences in rats. They compared baby rats who received less licking from their mothers with those who received more. They found that infants who received more licking were more stress resistant as adults. Next, the researchers investigated how these differences were reflected in brain cells. Epigenetic profiles – essentially maps of how genes express themselves – revealed distinct differences in cells from an area of the brain affected by caregiving. The bottom line: Behavioral traits in adults can be influenced by environmental exposure that affects gene expression.

Dr. Szyf is also working with Program Member Steve Suomi on similar research with Rhesus monkeys. They study differences in the monkeys' methylation patterns. (Methylation is one of the best understood ways to turn genes on and off.) By studying a group of monkeys raised by their natural mothers, and another raised by peers, they are working to find methylation differences that reflect these different caregiving situations.

While program members push forward with research results, they are also pioneering new methods for doing research. They are exploring the use of "peripheral" samples – blood or mucous cells – rather than "central" samples – such as brain cells – to identify epigenetic differences.

Such less invasive methods are of great importance to research on people. Program Director Ron Barr, child development expert Tom Boyce, and epigeneticist Michael Kobor for instance, are investigating whether differences in early caregiving influence human epigenetic profiles. For example, studies show some mothers hold their infants for up to six hours per day longer than others. The researchers are trying to analyze the effects of such differences by comparing epigenetic profiles from blood samples. This methodology sets the stage for analyzing the influence of many other environmental exposures on human development.

Program member and epidemiologist Clyde Hertzman is taking epigenetic profiling one step further – he is working with Dr. Szyf to evaluate how socioeconomic status relates to methylation patterns. Their preliminary work already points to a possible epigenetic basis for certain human characteristics that have long been correlated with socioeconomic status, including insulin responsivity, obesity, and the immune system.

Epigenetics is just one focus of the program. Other researchers study such areas as the effect of pre- and postnatal experiences on neural development, and critical learning periods during which children have maximum capacity to acquire language.

In addition to the landmark research of the past year, the program passed another milestone: an international peer-review of its first five years. As a result of this review, we are already identifying potential additional members, expertise and methodologies to help expand on our initial successes. As exciting as this year has been, the future holds even greater potential.

“My other entangled particle is a photon”

Modeled by Rob Zdancewicz, entrepreneur and take-charge kind of guy.

QUANTUM INFORMATION PROCESSING

By Raymond Laflamme, Program Director

Entangled photons are behind one of this year's biggest breakthroughs in CIFAR's *Quantum Information Processing* program.

When two particles are entangled, changes to the quantum state of one particle affect the other immediately, regardless of the distance between the particles. Entanglement is a principle of quantum mechanics that physicists use to manipulate information in a much more (sometimes exponentially more) powerful way than is possible through classical physics.

Program Member Gregor Weihs used entangled photons to create the world's first "free space quantum cryptography device." Quantum cryptography, a branch of quantum communications, harnesses another, equally bizarre property of the subatomic world: A quantum system changes merely by being observed. In quantum cryptography, information is encoded in entangled pairs of particles. Sender and recipient each have one of each entangled pair. By manipulating and observing these pairs, they can code and decode messages highly securely. And, if an interloper does try to take a peek at the particles, that mere act of observation will affect the pairs, sending an alert that the message has been compromised.

Program Member Hoi-Kwang Lo had identified vulnerabilities in previous quantum cryptography methods that could make messages vulnerable to hacking. Dr. Weihs' method resolves these issues, making quantum cryptography more reliable and practical.

An important question for implementing quantum devices is: How can we test whether they are actually doing what we want them to do? Program Member Michele Mosca is researching ways that a quantum apparatus can test itself. This idea might be vital for quantum cryptographic equipment that is vulnerable to malicious tampering or to degradation during use. Dr. Mosca's work started out as a fairly abstract idea, but thanks to the influence of CIFAR, has morphed into a powerful, tangible tool for experimentalists. Dr. Weihs and I, as well as several other program members, now plan to pursue self-testing for our systems.

Program Member Alexandre Blais, a theorist who is cross-appointed to CIFAR's *Quantum Materials* program, uses superconductors to process quantum information. With his collaborators at Yale University, Dr. Blais has created a "quantum bus." This system allows quantum information – sent in basic units called "qubits" – to be passed from one place to another. Most qubit studies to date have focused on storing information. Dr. Blais' work is the first example of transmitting it. This discovery has been highlighted in *Nature*, *Science* and *Physical Review Letters*.

As excited as I am by our advances of the past year, we still don't know where the power of quantum computation actually comes from. Our intuition tells us that more entanglement means more power, but we haven't succeeded in proving it. Program Members Debbie Leung and John Watrous are researching how quantum entanglement can help or hinder information processing. They were surprised to find examples of cooperative tasks for which you can never have enough entanglement. This means that even if two colleagues share a billion entangled particles, they could still achieve more with one more entangled particle. Our program seeks to better understand such peculiar phenomena, and to truly assess the power of quantum computation in the process.

We also plan to continue exploiting the power of quantum information to investigate key problems at the border between computer science and physics. Although we have an outstanding reputation worldwide, particularly in the area of computer science, we continue to expand and engage new program members to help achieve our goals. One of these additions is Associate Scott Aaronson, a computer scientist based at the Massachusetts Institute of Technology. Dr. Aaronson is well-known for his research into the limitations of quantum computers, for his blog, where he discusses everything from mathematics to mountains to politics, and for his contributions to Scientific American magazine. Dr. Aaronson brings his fresh perspective to our strong, multidisciplinary team of mathematicians, computer scientists, information theorists, and theoretical and experimental physicists.

"Ask me about the seven habits of highly successful societies"

Modeled by Anthony Upshaw, support worker and society builder.

SUCCESSFUL SOCIETIES

By Peter Hall and Michèle Lamont, Program Co-Directors

Researchers and non researchers alike have long known that the quality of social relations in a society has important effects on health and human development. However, there is still much to be learned about precisely how social relations impinge on health and about the role that cultural frameworks play in this process.

This past year, our members completed the collective volume, *Successful Societies: How Institutions and Cultural Repertoires Affect Health*. This book helps to fill that gap and opens up new perspectives on societal success. It tells the story of the relationship between social and cultural processes and the health outcomes of communities and countries. While we will never be able to isolate practices that would guarantee the success of every society in every context, we have learned much about why some societies are healthier, wealthier and more equitable than others.

Writing the book helped to define a distinctive research agenda for the program that continues to influence the work of our researchers. Among many other topics, its essays explore the social factors that yield differences in population health in the developed and developing worlds, how people cope with racism and stigmatization, and the conditions that underpin effective health policy. The volume sets a new agenda for research inside the program and within the social sciences more generally.

The influence of the program is apparent in Gérard Bouchard's involvement in the high-profile *Commission on the Reasonable Accommodation of Ethnic Minorities* for the Government of Québec. To that work, he brought concerns for issues of recognition and social inclusion prominent on the successful societies agenda.

Ron Levi's work this year also looks at issues of social inclusion from other perspectives. Among other ventures, he published articles that challenge stereotypes about immigrant youth and crime. Based on a large scale study, his findings show that first-generation immigrant youth are less likely than native adolescents to engage in criminal activities and that second-generation youth are no more likely than their native counterparts to do so.

In research that brings a sociological perspective to problems of public policy-making, Ann Swidler focuses on the social conditions that make efforts to prevent HIV infection in Africa more effective. In a well-received paper in *Science*, she and her collaborators point out that the most popular approaches to AIDS intervention, based on counseling, condoms, and sexual abstinence, are not working. Based on research into the cultural context in which prevention strategies operate, she argues for giving priority to male circumcision and reducing the number of sexual partners as more effective prevention strategies.

Dan Keating is investigating the gradients that link socioeconomic position to health, education and other dimensions of well-being. His focus has been on ways to assess the relationship between early childhood education and well-being over the life course. The objective is to devise better indicators for measuring the effects of child development programs and to improve their implementation. Dr. Keating has completed a major review of the existing evidence on this subject, including an analysis of the finding from the Early Development Initiative that originated in CIFAR's *Population Health* program.

The group has also been highly involved in knowledge transfer with other organizations. Clyde Hertzman, for instance, has been working to improve the United Nations convention governing the rights of children and with the World Health Organization's *International Commission on Social Determinants of Health*, which incorporates recommendations from the *Global Knowledge Report on Early Child Development* that Clyde co-authored.

The essays in *Successful Societies: How Institutions and Cultural Repertoires Affect Health* offer fresh perspectives on the problems of creating healthier societies that reflect the value of concerted interdisciplinary inquiry. The members of the program are actively following it up with research into the problems of translating successful institutional experience into new national contexts, into the social sources of the gradients defining social well-being, and into the role that cultural frameworks play in the constitution of social relations.

"Honey, let's take the electron out for a spin," "Let's paint the town photovoltaic," and "Trap the light fantastic"

Modeled by Darryl, Christie, and Mackenzie, nuclear family.

NANOELECTRONICS

By Peter Grütter, Program Director

Working with materials 10,000 times smaller than the width of a human hair, *Nanoelectronics* program researchers can create photonic crystals that trap and channel light, three-dimensional DNA structures that organize metals and nanoparticles, and nanocrystals that use electron spin to transfer information.

These are just a few of the approaches that our program is pioneering in the hunt for the next platform for electronics. Now at the end of its second five-year term, the *Nanoelectronics* program is overcoming some of the major challenges to designing, creating and manipulating materials at this tiny scale. CIFAR's interdisciplinary meetings make this possible: The program brings together chemists, physicists and engineers, who specialize in both experimental and theoretical research.

The year's key accomplishment illustrates what this unique blend can achieve. Nobel laureate John Polanyi, an experimental chemist, and Werner Hofer, a theoretical physicist, joined forces to improve the way molecular patterns are imprinted on a silicon surface. They developed a new method, called "molecular scale imprinting," that grows molecular structures in lines on silicon. This research drastically improved our understanding of the fundamental properties of this complex and useful surface, creating insights that have exciting implications not only for electronics, but also for catalyzing chemical reactions and converting solar energy into energy that we can use.

Another exciting advancement emerged from Program Member Sajeev John's research. Dr. John, a theoretical physicist, and fellow Program Member Geoff Ozin, a materials chemist, are experts on photonic band gap materials, crystalline structures that trap, guide and control light. This year, Dr. John took these materials to another level: He developed a new photonic crystal architecture that weighs less and is able to trap light, or photons, longer. The more time a photon spends in the crystal, the more time researchers have to compute with it. Dr. John's photonic crystals also have the potential to boost the efficiency of solar cells. He expects this architecture to open a new area of research at the intersection of materials science, optics and quantum physics, and shed light on how to control the quantum behaviour of single photons for computation.

While Dr. John's work harnesses the power of the quantum world, Hanadi Sleiman's work looks to nature for inspiration. Dr. Sleiman's latest DNA nanostructures extend into the third dimension, carrying tremendous potential for applications with them. Her research group has synthesized two-dimensional shapes out of DNA, such as triangles, squares, pentagons and hexagons, and linked them with DNA strands to create three-dimensional DNA cages. These cages could trap and release drugs, regulate how proteins fold and act, and assemble three-dimensional networks that act as catalysts for chemical reactions. Dr. Sleiman is collaborating with several physicists in the *Nanoelectronics* program, including Thomas Szkopek, Martin Moskovits and me, to study these cages and assess their applications.

This is very powerful research, and with great power comes great responsibility. With more than 600 nanotechnology-based consumer products currently on store shelves – from sunscreens and anti-stain coatings to medical devices and electronics – regulation is becoming a hot topic. This year I was on a panel organized by Health Canada, Environment Canada and the Council of Canadian Academies to assess the safety of nanomaterials and make recommendations for how to manage them.

One of the main challenges to regulating nanomaterials is deciding what should trigger a regulatory response. Many parameters come to mind, including size, surface area and toxicology. What is more, many nanomaterials are not yet fully characterized – we don't always know enough about them to make informed regulatory decisions. We have made several recommendations:

1) to develop standardized definitions and nomenclatures to help fill knowledge gaps (This is underway)
2) to create new tools and standards to monitor exposure, and to share that information widely, across Canada and around the world
3) to conduct more interdisciplinary research, a goal CIFAR is helping us to achieve

"Genes working with genes to create a better tomorrow"

Modeled by Desiree Tillo, researcher and genetic networker.

GENETIC NETWORKS

By Brenda Andrews, Program Director

New genetic links to disease are discovered every day. And as genome sequencing becomes more accessible, multiple terabytes of data reach researchers' fingertips.

It is clear that we need to better understand our genes in order to harness the potential of sequencing genomes. But less obvious is the fact that common disorders are a proven result of many different genes interacting with each other and with environmental factors. We must look beyond individual genes and unravel how they work together as networks to make us sick and keep us healthy.

The *Genetic Networks* program studies these genetic interactions. One of the main approaches we use to achieve this is studying model systems: organisms such as yeasts, nematode worms, and rats.

Many program members use genetic information from these model systems to assess whether genetic interactions are conserved between species. For instance, the yeast genetic network map that program members Charlie Boone, Howard Bussey, Brendan Frey and I are constructing could tell us a lot about what's going on at the genetic level in mammalian cells, including our own.

This was a breakthrough year for the group in testing whether genetic interactions are conserved between species.

Dr. Boone and I are testing conservation by comparing two species of yeast, one that reproduces by forming buds, the other by splitting, or fission. Although these two organisms are both yeasts, they are distantly related, separated by a lengthy one billion years of evolution. They are also biologically different – fission yeast cells exhibit some characteristics more similar to human cells than budding yeast cells do. Despite these differences, we noted that budding and fission yeast share some three-quarters of their genes. As much as one third of their genetic interactions are also the same. This news, which will be published shortly, hints at the existence of a core genetic network for evolutionary distant eukaryote cells, which include those of humans. The next step in this work is to compare the genetic interactions in yeast, which are unicellular, with more complex, multicellular organisms.

This positive result for distantly related species of yeast re-energizes the field of research into genetic interactions. Earlier in the year, research in nematode worm models had made the opposite conclusion – that genetic interactions are unlikely to be predictive between species. This research was conducted by new Program Member Andrew Fraser. CIFAR helped recruit Dr. Fraser from the Wellcome Trust Sanger Institute in the UK. He now conducts his internationally renowned genetics research at the University of Toronto. This past year, Dr. Fraser performed the most widespread phenotypic analysis of the worm, and compared his results with genetic information from the budding yeast network. He discovered that less than 10% of interactions are conserved between the two organisms. However, further analysis may be required to confirm that the observable characteristics of unicellular organisms such as cell fitness, which are measured to determine the effect of genetic interactions, can be extended to multicellular organisms.

Yeast geneticists have long looked at colony size as an indicator of cell fitness, but are now moving beyond that, to analyze other characteristics that shed light on how genetic interactions affect important biological processes in the yeast cell.

For example, I am studying how a key tool in the cell, the mitotic spindle, changes when different pairs of genes work together. The mitotic spindle is a mass of tiny fibres seen when cells divide; the fibres radiate from two poles and meet at the equator in the middle of the cell, enabling division. Studying the mitotic spindle sheds light on mitosis, the vital process in which a eukaryotic cell separates the chromosomes in its cell nucleus, into two identical sets in two daughter nuclei.

The goal of this work is to try to find out what genes control spindle morphology and dynamics. It brings sensitive cell biological assays into studies of genetic networks, another big step forward in understanding how genes interact.

"What part of 'quantum oscillations in the superconductor pseudogap' don't you understand?"

Modeled by Matthew Bebenek, irresistible student.

QUANTUM MATERIALS

By Louis Taillefer, Program Director

Hearing people talk about the quantum world can be like listening to a conversation in a foreign language. In some ways, the terminology of subatomic physics is even harder to understand, because many of the concepts behind these terms are untranslatable: There are no real-world metaphors for many of the strange quantum phenomena we study.

Luckily, you don't need to know what a pseudogap is to understand the huge potential for the materials we are studying. Superconductors are materials that conduct electricity without resistance. Many superconductors only work at extremely low temperatures – close to absolute zero. Other materials, known as "high-temperature superconductors," still need to be very cold in order to function, but they are at least sometimes practical to use.

High-temperature superconductors are used in MRI machines, ultrathin power lines and high-speed levitating trains.

To harness the true power of superconductors, though, we are trying to get them to work at room temperature. And to do that, we must better understand what actually causes their exotic properties.

CIFAR's *Quantum Materials* program solved a great mystery last year. The jargon-laden account is that we observed quantum oscillations in the pseudogap of certain high-temperature superconductors, which proved that these materials had Fermi surfaces. To say it more succinctly, we discovered that these materials are, in fact, metals. This may not seem Earth-shattering, but that single piece of information provides the key that scientists have been searching for: It tells us where to go to solve the question of room-temperature superconductors.

This discovery has had exceptional impact – our research paper on this subject has already garnered almost 50 citations.

In fact, just six months after we published, program members Walter Hardy, Doug Bonn, Ruixing Liang and I have already moved from discovery to characterization of these physical properties. A problem that was once entirely puzzling has become manageable and, I believe, solvable. We looked deep into the pockets of these materials, the source of their superconductivity, and discovered electrons. This result was completely unexpected: about 99.9% of theories predicted the opposite, that holes on the surface, where electrons are absent, were actually the charge carriers. We now need to understand why electrons reside in those pockets, and what the mechanism is that brought them there.

This latest discovery is the tip of a whole new iceberg. It takes us much closer to answering the biggest question of all: What is the force between electrons that drives superconductivity?

We are advancing on other fronts as well. Until a few months ago, copper-based materials, such as the ones I work with, were the most promising high-temperature superconductors. But new Associate Hai-Hu Wen from the Chinese Academy of Sciences in Beijing recently discovered superconductivity in some iron-based materials as well. Not only are these iron-based materials an exciting addition to the superconductor family, they are also a promising tool for better understanding their copper-based cousins.

Another international addition to the program is looking for superconductivity in a more unusual place: at the interface between two materials. Advisory Committee Member Jochen Mannhart from Germany is studying the interface between two insulating oxides, materials that resist the flow of electric current and form a cloud of electrons at their interface. Dr. Mannhart showed that the conductivity of this cloud of electrons can be tuned by altering the thickness of one of the insulating oxides, or by applying a voltage, much like in a transistor. He also showed that at very low temperatures, the interface enters a superconducting state. Dr. Mannhart is just beginning to explore this system, and his results promise to reveal some truly spectacular physics.

Many members of the *Quantum Materials* group, including Allan Griffin, Kirk Madison, Joseph Thywissen, and Fei Zhou, study the strange quantum behaviour of other materials called cold atoms. Also known as Bose-Einstein Condensates, cold atoms are gases that, below a certain temperature, suddenly interact very strongly. In this state, they are like a superfluid – a fluid that flows without friction. CIFAR organized a meeting called the Cold Atoms Workshop this past spring, where theoretical and experimental experts gathered to discuss this exciting class of materials. Cold atoms have implications for making precision measurements, building a quantum computer, and much more.

The common goal behind investigations of all these quantum materials is that we must better understand their behaviour before we can exploit their powerful properties. CIFAR's principles of collaboration and interdisciplinarity are driving forces for achieving this goal. We look forward to shedding even more light on the quantum world, thanks to CIFAR, next year.

"Happiness is $LS_{ij} = \alpha + \delta \ln(y_{ij}) + \mu X_{ij} + \gamma Z_j + \varepsilon_i$"

Modeled by Je-an Salas, pilates instructor and balanced human being.

SOCIAL INTERACTIONS, IDENTITY AND WELL-BEING

By John Helliwell and George Akerlof, Program Directors

Most of the people who originally gathered together to form *Social Interactions, Identity and Well-Being* began with no previous connections to each other. In the two years since the program's inception, though, we have coalesced and unified. Members' diverse expertise has converged on many common interests and together we have forged a fresh, bold research agenda.

What is that agenda?

We are interested in well-being and happiness, in identity, in schooling, in gender relations, in immigration, and in macroeconomics.

We view human motivation from the point of view of the whole being: We do not believe that we should separate psychological, economic, and social motivation. In fact, they are so intertwined that to properly understand one, we must study them all.

While this may seem commonsensical to many non-economists, in the world of traditional economics, it is nothing short of revolutionary.

On the other hand, it may appear nonsensical to see a concept such as happiness quantified in the complex equations and formulae that are the lynchpins of economic research. And yet, our research has shown time and time again that very human concepts such as well-being and identity hold up robustly to the scientific rigour of academic investigation.

By bringing the program's three titular subjects into the economic sphere, we are shaking up an impressively wide spectrum of research areas.

Members of the group are engaging in studies on immigration, education, macroeconomics, the causes of happiness and well-being, the causes of poverty, (especially minority poverty), the role of gender in home and in the work place, race and ethnic relations, the relation between the bureaucracy and the poor, and many other topics.

Our three meetings this year prominently featured political scientists, psychologists, sociologists, anthropologists, economists, and more.

One of the many high points from this year was a combined meeting between our program and the group "Social Change: A Harvard-Manchester Initiative." This meeting, which took place near Manchester, England, gave us an opportunity to get an overview of the most current relevant research into immigration in the UK and Europe.

All three of our program's central themes, social interactions, identity, and well-being, are central to how well immigration and diversity are handled, especially in urban areas. Cities are where turnover is highest and the challenges greatest for the establishment of social capital, well-being, and encompassing identities. We discussed integration, cultural attitudes, ideologies and much more. This research plays a crucial role in how well cultures, societies and economies can adjust to and benefit from increasing diversity.

While program members bring their collective perspective to sweeping issues like immigration and cultural diversity, they also drill down into many more specific research areas. Whether it's the role identity plays in collective beliefs and delusions in the business world, or the way social groups can improve the quality of life for stroke victims, CIFAR researchers are pursuing many aspects of life that are shaped by social interaction, identity and well-being.

One member, for instance, researches the remarkable growth in women's participation in the labour market – the most significant change in the labour market in the last half century. A particularly important impetus for that growth was the Women's Liberation Movement of the 1970s. One of the things this movement accomplished was to propose a new identity of "career woman." Before this time, many women considered "homemaker" to be their salient identity. Our research has shown that people are happiest and most productive when they feel they are living up to the identity they believe they should exemplify. Clearly, when a new identity paradigm gained traction among women, the impact on the economy was massive.

A great success of this program has been our work in making sure the research gets out into the world. *Social Interactions, Identity and Well-Being* members have spoken to and consulted with influential groups all over the world, including the World Bank, the European Economic Association, the Canadian Psychological Association, the Federal Reserve Bank of Boston, and many, many more. One of our proudest accomplishments is that our research is making a real impact in the world.

“The eyes are the window to the brain”

Modeled by Sophia: owner and operator of one of the most powerful computers on the planet.

NEURAL COMPUTATION AND ADAPTIVE PERCEPTION

By Geoffrey Hinton, Program Director

While you can't always tell what someone is thinking when you look into their eyes, you can gain tremendous insight into how the human brain works by studying the way we see. The members of *Neural Computation and Adaptive Perception* study the human visual system, and attempt to reproduce its many astounding capabilities through computer algorithms.

Human vision is about much more than registering brightness, shape and colour. When we look at an image or a scene, we pick out objects and edges, detect motion, infer what might be hidden behind foreground objects. Even more incredible, we make sense of what we see: discerning shapes that have symbolic meaning, such as letters and numbers; identifying a person as male or female; recognizing family resemblances; comparing and categorizing what we see to assess patterns, dangers, opportunities and other forms of meaning.

A disproportionately large portion of our brains is devoted to visual processing. This suggests that we primarily understand our world through sight, and that studying how we perceive the world visually may be the optimal means for answering the big questions about how the human brain works.

To this end, our program made several major advances this year.

Collaborations between several program members, for instance, have led to significant advances in computers learning to identify motion in video – like tracking the movement of a human being against a cluttered background. In addition to identifying foreground and background, picking out objects and edges and other key tasks, these computer systems also incorporate realistic physics-based models and use other kinds of data to make inferences and ensure that motions are physically plausible.

These new models help us understand how humans perceive the gestures and actions of people and other animals. They will also enable myriad applications in areas as diverse as markerless motion capture (a major step beyond the current technology used to create animated characters based on the movements of live actors, such as *The Lord of the Rings*' Gollum) occupational theory and biomechanics, and video surveillance.

Another collaborative effort among NCAP members at MIT, NYU and the University of Toronto has led to a significant breakthrough on a fundamental visual ability that, while effortless for human beings, has proved very challenging to computers: the ability to retrieve images that resemble a query image.

You might think that search engines such as Google can already do this – if you ask Google for pictures of airplanes, it will return thousands of them to you. But to do this, the search engine's computers do not actually look at what is in the images – it uses caption information and surrounding textual context to generate its results. So, in addition to images of Boeing 767s, you might also get images of Jefferson Airplane album covers and pictures of parents swinging their children around in circles.

The new methods pioneered by *Neural Computation and Adaptive Perception* members empower computers to categorize the actual content of images themselves, which allows for very fast image retrieval. (Additional computing must still be done after this retrieval to weed out poor matches.)

Google, which recently provided funding to facilitate this research, has also put "Techtalks" by program director Geoffrey Hinton and Program Member Rob Fergus on Youtube.

Thanks to these and many other advances, the program's ultimate goals of understanding how, exactly, our brains interpret the world, and simulating that facility in an artificial system are closer now than ever before.

MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL RESULTS

As at June 30, 2008

RESULTS OF OPERATIONS

The 2008 fiscal year was an important year for CIFAR, with the completion of a 5-year strategic plan for the organization. This plan provides a roadmap for growth and increased accomplishment for the Institute, and provides valuable criteria with which to evaluate new and existing initiatives. We also continued to make progress in securing long-term, stable financial footing for CIFAR through 2012 and beyond.

Income for the year to June 30, 2008 totaled $20.3 million. This amount was $1.7 million lower than the $22 million of revenue received in the prior year. During the year, the Institute entered into a new funding agreement with the Province of Quebec, bringing the total number of provincial governments supporting CIFAR to four, and resulting in income from provincial sources of $11.3 million, after deferring $3 million to future periods. Income from the federal government of $5.0 million reported in 2008 is the same as the prior year. Private sector donations of $2.7 million were down $230 thousand, or 8%, from the prior year.

The number of individuals contributing to the Institute has continued to increase. There were a total of 242 donors in the current fiscal year, up from 225 in the prior fiscal year.

Other income of $320 thousand represents sponsorship income to cover costs of the twenty-fifth anniversary celebration, compared to $130 thousand in the prior year. Other income in 2007 also included honorariums related to the Founders' Network, which no longer receives financial support from CIFAR.

Investment income represents income of $1 million earned and received on portfolio investments during the year, an increase of 42% over the prior year due to higher short-term deposits as well as higher rates of return. In addition, CIFAR recognized unrealized losses in the market value on the investments held for long-term investment of $613 thousand as a decrease in net assets. A foreign exchange gain of $156k related to CIFAR's US dollar denominated bond portfolio was recorded as an increase in net assets.

Expenses were $13.4 million for the year, up from $12.7 million, an increase related to growth in two of the more recently launched research programs, as well as increased activity in CIFAR's ten other programs and new initiatives.

Program expenses were $10.9 million for the fiscal year 2007-08, which is $76 thousand, or 1%, higher than the prior year of $10.8 million, comprised as follows:

Active Programs – Direct expenditures of $8.2 million for researchers' compensation and interaction costs were $261 thousand lower than last year's cost of $8.5 million. While most programs experienced growth in the number of program members, increased expenditures were offset by the reduction in expenditures related to the closing of CIFAR's Evolutionary Biology program, which concluded in June 2007. Total program members at June 30 were 284, down from 302 in June 2007.

Active Programs – Support expenditures of $1.9 million were $80 thousand higher than the prior year. Although there was a 4.4% increase in the overall cost structure, including increased expenditures on new initiatives such as knowledge transfer, international reach and an interdisciplinary study, activities related to program reviews and new program development were lower than the prior year due to fewer program reviews.

Other expenses of $754 thousand were higher than the amount expended in the prior year, due to expenditures associated with CIFAR's twenty-fifth anniversary, which was primarily celebrated in the 2008 fiscal year.

Non-program expenses, consisting of Advancement and Communications and Governance and Administration, were 24% higher than expenditure levels for the prior year due largely to the increase in the number of employees hired to support the growth in activity, related expenses such as rent and other overhead, as well as increased expenditures on communications, including expenditures related to outreach activities and improvements to CIFAR's website.

BALANCE SHEET, LIQUIDITY AND CAPITAL RESOURCES

The **working capital** of the Institute was $5.8 million at the year end, due to high cash and short-term deposit balances, and a high current portion of investments balance.

Long-term investments increased by $2.4 million during the year. The increase is primarily due to the excess of income over expenses and a corresponding increase of $5 million in the See Far Fund, of which $4 million was invested in additional long-term investments and $1 million was invested in additional bonds during the year. There was a decrease of $2 million due to the maturing of bonds relating to the Province of British Columbia grant. A further decrease of $613 thousand was due to a decrease in portfolio values during the year.

During the 2007 fiscal year, the board approved the establishment of the **See Far Fund** for the purpose of setting aside funds for the future needs of the Institute. During the year, a further $5 million of the unrestricted net assets was transferred to the See Far Fund at year-end, for a total fund balance of $20.8 million at June 30, 2008. The assets of the fund consist of an equity portfolio ($9.7 million) and a bond portfolio ($11.1 million). The Institute also received its **first endowment bequest** of $500 thousand.

The **net asset position** increased by $6.9 million during the year, as a result of the excess of income over expenditures of $6.9 million, and the receipt of endowment funds of $500k, offset by a decrease in portfolio values of $613 thousand during the year. The level of Unrestricted Net Assets, combined with the current portion of deferred income, of $13 million represents the equivalent of approximately 9 months of 2008-2009 budgeted expenditures.

RISKS AND UNCERTAINTIES

The activities of the Institute are funded entirely by **public sector grants and private sector donations**.

CIFAR has agreements or received commitments for an aggregate amount of government funding of $31.5 million to fund CIFAR's research over the next four years. Although these agreements and commitments remove much of the uncertainty from CIFAR's public sector grants for the next four years, CIFAR must continue to seek private sector donations. While the Institute has met its private sector funding requirements in the past, there is no guarantee that it will continue to do so in the future.

The ability to budget **program expenditures** to discrete periods is affected by many factors outside the control of the Institute, including the timing of appointments to various programs. This is especially the case when new programs are being established.

The **market value** of investments varies over time. The funds held for long-term investment in the See Far Fund, currently invested with the University of Toronto's LTCAP fund, are now at a market value of $9.7 million, surpassing the original cost of $9.2 million for the portfolio. However, the Institute may incur losses if it is required to liquidate investments prematurely or if underlying securities decline in value permanently.

AUDITORS' REPORT

2008 SUMMARIZED FINANCIAL STATEMENTS

TO THE BOARD OF DIRECTORS OF
THE CANADIAN INSTITUTE FOR ADVANCED RESEARCH -
L'INSTITUT CANADIEN DE RECHERCHES AVANCÉES

The accompanying summarized statement of financial position and summarized statements of operations, changes in net assets and cash flows are derived from the complete financial statements of **The Canadian Institute for Advanced Research - L'Institut Canadien de Recherches Avancées** as at June 30, 2008 and for the year then ended on which we expressed an opinion without reservation in our report dated August 23, 2008. The fair summarization of the complete financial statements is the responsibility of management. Our responsibility, in accordance with the applicable Assurance Guideline of The Canadian Institute of Chartered Accountants, is to report on the summarized financial statements.

In our opinion, the accompanying financial statements fairly summarize, in all material respects, the related complete financial statements in accordance with the criteria described in the Guideline referred to above.

These summarized financial statements do not contain all the disclosures required by Canadian generally accepted accounting principles. Readers are cautioned that these statements may not be appropriate for their purposes. For more information on the entity's financial position, results of operations and cash flows, reference should be made to the related complete financial statements.

PKF Hill LLP

Chartered Accountants, Licensed Public Accountants
August 23, 2008
Toronto, Ontario

PKFHill
CHARTERED ACCOUNTANTS

THE CANADIAN INSTITUTE FOR ADVANCED RESEARCH

SUMMARIZED STATEMENT OF FINANCIAL POSITION

As at June 30

	2008	2007
ASSETS		
Cash and short-term deposits	$ 8,507,437	$ 3,644,696
Accounts receivable and prepaid expenses	1,341,552	1,407,619
	9,848,989	5,052,315
Investments, including current portion	31,815,188	29,380,660
Equipment and leasehold improvements, at net book value	275,204	161,079
Total assets	**$ 41,939,381**	**$ 34,594,054**
LIABILITIES AND NET ASSETS		
Accounts payable and accrued liabilities	$ 2,458,209	$ 2,647,338
Deferred income, including current portion	10,401,049	9,782,275
Total liabilities	12,859,258	12,429,613
Net assets		
Invested in equipment and leasehold improvements	275,204	161,079
See Far Fund		
Externally restricted for endowment	500,000	-
Internally restricted	20,324,600	15,271,466
Cumulative unrealized gain on available-for-sale investments	476,100	1,103,934
Unrestricted	7,504,219	5,627,962
Total net assets	29,080,123	22,164,441
Total liabilities and net assets	**$ 41,939,381**	**$ 34,594,054**

See accompanying note

SUMMARIZED STATEMENT OF OPERATIONS

Year ended June 30

	2008	2007
INCOME		
Program contributions		
Private sector	$ 2,681,623	$ 2,912,473
Federal government	5,000,000	5,000,000
Provincial governments	11,268,750	13,090,000
Other contributions	320,000	261,887
Investment income	998,057	705,486
Total income	20,268,430	21,969,846
EXPENSES		
Program expenses		
Active programs, direct		
Cosmology and Gravity	1,039,003	1,350,386
Earth System Evolution	651,983	552,534
Evolutionary Biology	(97,665)	564,631
Experience-based Brain and Biological Development	511,634	522,887
Genetic Networks	459,246	363,826
Institutions, Organizations and Growth	714,783	775,440
Integrated Microbial Biodiversity	549,815	41,000
Nanoelectronics	980,529	1,043,742
Neural Computation and Adaptive Perception	446,725	402,358
Quantum Information Processing	682,129	720,075
Quantum Materials/Superconductivity	1,039,865	1,009,988
Social Interactions, Identity & Well Being	504,926	381,687
Successful Societies	782,766	799,357
	8,265,739	8,527,911
Active programs, support		
Program Development and Assessment	1,480,760	1,350,207
Program Reviews and Research Council	108,668	299,402
Knowledge Transfer	60,544	29,154
International Reach	17,542	-
Interdisciplinary Study	94,050	-
New Program Development	122,439	125,331
	1,884,003	1,804,094
Other	754,876	355,527
Total program expenses	10,904,618	10,687,532
Advancement and communications	1,827,350	1,482,400
Governance and administration	628,048	524,825
Other	36,116	-
Total expenses	13,396,132	12,694,757
Excess of income over expenses	$ 6,872,298	$ 9,275,089
Allocated to:		
Invested in equipment and leasehold improvements	$ (133,938)	$ (88,998)
See Far Fund	5,053,100	9,139,500
Unrestricted	1,953,136	224,587
	$ 6,872,298	$ 9,275,089

See accompanying note

SUMMARIZED STATEMENT OF CHANGES IN NET ASSETS

Year ended June 30

	2008	2007
Balance, beginning of year	$ 22,164,441	$ 12,069,689
Excess of income over expenses	6,872,298	9,275,089
Endowment contribution	500,000	-
Unrealized gain on foreign currency	156,184	-
Unrealized gain (loss) on investments	(612,800)	819,663
Balance, end of year	$ 29,080,123	$ 22,164,441

See accompanying note

SUMMARIZED STATEMENT OF CASH FLOWS

Year ended June 30

	2008	2007
Operating activities		
Excess of income over expenses	$ 6,872,298	$ 9,275,089
Unrealized loss on investments	-	44,413
Amortization of equipment and leasehold improvements	133,938	118,600
Changes in non-cash working capital	495,712	4,064,357
Cash flows from operating activities	7,501,948	13,502,459
Financing activities		
Endowment contribution and cash flow from financing activities	500,000	-
Investing activities		
Investments	(2,891,144)	(14,612,123)
Equipment and leasehold improvements	(248,063)	(29,602)
Cash flows from investing activities	(3,139,207)	(14,641,725)
Net increase (decrease) in cash position during the year	4,862,741	(1,139,266)
Cash and short-term deposits, beginning of year	3,644,696	4,783,962
Cash and short-term deposits, end of year	$ 8,507,437	$ 3,644,696

See accompanying note

NOTES TO SUMMARIZED FINANCIAL STATEMENTS

Year ended June 30

1. NATURE OF OPERATIONS AND BASIS OF FINANCIAL STATEMENTS

The Canadian Institute for Advanced Research - L'Institut Canadien de Recherches Avancées (the "Institute") is incorporated under the Canada Corporations Act as a not-for-profit organization and is a registered charity under the Income Tax Act (Canada). The primary objective of the Institute is to bring leading researchers together to work on major collaborative advanced-research projects that address scientific, economic and social questions that are of importance to the future of Canada and the world. The Institute funds multi-year projects that bridge institutional, regional, cultural and national boundaries. The funding provided by the Institute contributes to research support and salaries of program members.

In common with other not-for-profit organizations, the Institute is economically dependent on the continued financial support of federal and provincial governments and the private sector to meet its ongoing commitments.

CIFAR ANNUAL DONORS

(Donations received between July 1, 2007 and June 30, 2008)

VISIONARIES' CIRCLE
($100,000 +)

$10.75 million
Government of Ontario

$5 million
Government of Canada

$2 million
Government of British Columbia

$750,000
Government of Alberta

$500,000
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