Lecture Abstracts

Contexts

Sir Crispin Tickell
Humans: Past, Present and Future

In the history of life on Earth the human species is a very latecomer. But the human impact on the Earth has slowly and then rapidly increased, most of all in the last 250 years, to what has been widely predicted as an unsustainable level in just a few generations hence.

The main factors are human population increase, degradation of land, consumption of resources, water pollution and supply, climate change, destruction of biodiversity and other species, the widening division between rich and poor, the risk of conflict, and the technological fix. Technology could hold the key to human survival or its destruction. Despite life on Earth being robust, human survival is not guaranteed. Technology may throw up some interesting options, but it is how we govern these options that will count.

There are solutions to most of problems we have created, but we will have to radically change our thinking on global governance and the whole spectrum of international affairs.

Catastrophe, Social Collapse, and Human Extinction
Robin Hanson

Humans have slowly built more productive societies by slowly acquiring various kinds of capital, and by carefully matching them to each other. Because disruptions can disturb this careful matching, and discourage social coordination, large disruptions can cause a "social collapse," i.e., a reduction in productivity out of proportion to the disruption. For many types of disasters, severity seems to follow a power law distribution. For some of the types, such as wars and earthquakes, most of the expected harm is predicted to occur in extreme events, which kill most people on Earth. So if we are willing to worry about any war or earthquake, we should worry especially about extreme versions. If individuals varied little in their resistance to such disruptions, events a little stronger than extreme ones would eliminate humanity, and our only hope would be to prevent such events. If individuals vary a lot in their resistance, however, then it may pay to increase the variance in such resistance, such as by creating special sanctuaries from which the few remaining humans could rebuild society.

Avoiding Millennialist Cognitive Biases
James Hughes

I will outline a typology of the pancultural millennial phenomena, describe their characteristic cognitive biases—over-optimism, over-pessimism, fatalism and messianism—and suggest how contemporary forms of secular techno-utopian and techno-apocalyptic discourse reflect these types of millennial psychology. Then I propose that an awareness of the characteristic dysfunctional cognitive distortions associated with millennialism helps us separate grounded assessments of the risks and benefits of emerging technologies, and prophylactic public policies, from their psycho-cultural baggage.

The Tragedy of the Uncommons
Jonathan Wiener

The classic "tragedy of the commons" phenomenon may plague many shared resources, but over time social institutions can learn from experience with resource depletion and pollution, and can develop effective remedies. By contrast, rare extreme catastrophic events—"tragedies of the uncommons"—pose a different and less tractable challenge. As societies solve the "commons" problems, new "uncommons" risks loom larger. Yet "uncommons" events do not present the kind of salient visible early warning signals that tend to galvanize popular politics to respond to "commons" problems. Can societies and their governance institutions devise ways to anticipate, prevent and survive such rare extreme catastrophic events?

Rationally Considering the End of the World
Eliezer Yudkowsky

The decision to think rationally is a preliminary challenge in any human endeavour. To land a spaceship on the Moon, you must solve problems of physics and engineering. But before you can even attempt such problems, you must think of the Moon as a goal to be attained, not a wondrous tale to be told; the physics must be a problem to be analyzed, not a mystery to be worshipped; the engineering must seem a challenge to creative ingenuity, rather than an invitation to trust to luck. The foundational requirement for humanity to successfully confront and resolve global catastrophic risks may be simply that we stay in a scientific/engineering frame of mind. I consider some common departures from this frame, and offer general principles for staying within it.

Insurance and Catastrophes
Peter Taylor

This talk looks at the way financial losses associated to catastrophes can be mitigated by insurance, what insurers mean by catastrophe and risk, and how computer modelling techniques have tamed the problem of quantitative estimation of many hitherto intractable extreme risks. Having assessed where these techniques work well, I will analyse why they can be expected to fall short in

describing emerging global catastrophic risks such as threats from bio-technology. The presentation will also examine some recent research into techniques which offer some promise in assessing such emerging risks.

Disasters, Ecological Diversity, and the Future of Humanity
Christopher Wills

How quickly can the world's biological systems recover their diversity in the aftermath of ecological catastrophes that cause widespread local and global extinctions of species? This question can be answered by examining the forces that maintain and increase ecological and genetic diversity at the present time. Here I look at two of these processes: those that increase human genetic diversity, and those that maintain and increase tropical forest diversity. I suggest that both have been aided by a particular type of natural selection known as negative frequency-dependent selection, and I conclude that this type of selection may aid in the recovery of diversity following catastrophes.

The evolution of human intellect and of intellectual diversity has been driven by a feedback loop between our brains, our genes and our highly challenging environment. Negative frequency-dependent selection has made all of our brains slightly different from each other, so that collectively as a species we can accomplish far more than a single individual ever could.

We have recently shown that this same process of frequency-dependent selection has driven the evolution of tropical rainforests, allowing complex ecosystems to evolve that are capable of utilizing the environment far more efficiently than a single species could.

Finally, the lecture will look at the fragility of these complex ecosystems. In collaboration with tropical ecologists worldwide, we have now demonstrated that a small reduction in the complexity of tropical rainforests will have a substantial negative impact on the growth and survival of the remaining species. Therefore the value of complexity and diversity in the natural world is high, and we put ourselves at risk if we do not maintain it.

Steve Rayner
Culture and the Credibility of Catastrophe

Prophesies of doom and the anticipation of cataclysmic events have been a perennial feature of human discourse in both oral and written traditions. Characteristically they involve a super- or extra-human force—gods, ancestors, or nature—which will intervene in human affairs. They also embody strong moral or ethical imperatives, either to reform current social behaviour so that catastrophe can be averted, or to establish a more ideal social order once the present dispensation has been swept away.

Although contemporary preoccupations with catastrophe claim to have a strong scientific basis, they continue to embody these traditional characteristics. Drawing on medieval millenarianism, 20th Century Melanesian cargo cults, ultra-left political groups and contemporary environmental discourses, this paper explores the social conditions that create a more or less fertile environment for the credibility of catastrophic predictions and the deployment of such predictions in contemporary policy discourse.

Michelangelo Mangano
Expected and Unexpected in the Exploration of the Fundamental Laws of Nature

The research of the fundamental laws of Nature brings scientists, by definition, at the edge of the known, and beyond. Whenever new major steps in this exploration are about to start, concerns are raised about the possibly malign nature of the new phenomena that may be activated. How does the knowledge of the "known" allow scientists to anticipate the possible consequences of the "unknown"? The discussions over the possible outcomes of new high-energy experiments will be used as a case study to address this topic, covering both the scientific and sociological aspects of the issue.

Hostile Acts

Catastrophic Nuclear Terrorism: A Preventable Peril
William Potter and Gary Ackerman

One can conceive of at least three potentially catastrophic events involving the energy of the atom: a nuclear accident in which massive quantities of radiation inadvertently are released into the environment; nuclear war among nation-states; and nuclear violence inflicted by non-state actors. This lecture focuses on the latter threat--the dangers posed by nuclear terrorism, a phenomenon that lies at the nexus between what are widely considered to be two of the primary security threats of the modern era.

Non-state actors have essentially four mechanisms by which they can exploit civilian and military nuclear assets intentionally to serve their terrorist goals: the dispersal of radioactive material; attacks against or sabotage of nuclear facilities; the theft, purchase, or receipt of fissile material leading to the fabrication and detonation of a crude nuclear explosive; and the theft, purchase, or receipt and detonation of an intact nuclear weapon. All of these nuclear threats are real, all merit the attention of the international community, and all require the expenditure of significant resources to reduce the likelihood and impact of their occurrence. The threats, however, are different and vary widely in their probability of occurrence, their consequences for human and financial loss, and the ease with which one can intervene to reduce their destructive outcome. This lecture will focus on the two forms of 'high consequence' nuclear terrorism, those involving INDs and intact

nuclear weapons.

We will examine the theoretical requirements for engaging in nuclear terrorism, outline the current evidence for and possible future shape of the threat, and then discuss the potential short- and long-term global consequences of nuclear terrorism. We conclude with policy recommendations for mitigating this particular species of global catastrophic risk. Throughout, we approach the issue from the dual perspective of the "supply side" of the risk (which, *inter alia*, concerns the availability of fissile materials and the capabilities of non-state actors in this context) and the "demand side" (which focuses on the motivations and identity of potential perpetrators of nuclear terrorism).

The Continuing Threat of Nuclear War
Joseph Cirincione

The risks of a global thermonuclear war are small, but they are not zero. In the seven decades of the nuclear age mistakes and miscalculations have brought the world perilously close to Armageddon.

The dangers have continued after the end of Cold War. In 1995, Russian military officials mistook a Norwegian weather rocket for an American nuclear attack and recommended a launch of nuclear missiles. Then-President Boris Yeltstin overruled the military at the last minute. An unauthorized attack by one Russian nuclear-missile submarine would result in 11-17 million civilian casualties, devastating a region larger than France and the United Kingdom combined. A limited attack in response by a single American submarine would likely result in 30-45 million Russian casualties.

Today, Russia and America possess 96 percent of the world's estimated 26,000 nuclear weapons. Several thousand are still deployed on hair-trigger alert, ready to launch within 15 minutes with the equivalent explosive firepower of 70,000 Hiroshima bombs. A typical 100-kiloton warhead would kill everyone within the 8.6 km diameter circle of its impact point; firestorms would kill millions more; radioactivity from the blast would kill all exposed within a 10-60 km zone downwind of the explosion.

There is also the possibility of a regional nuclear war between the rival nations of India and Pakistan. Due to high population densities, a regional war using the lower-yield atomic weapons each side possesses would also result in massive casualties. With short flight times providing little or no warning and dense urban cores to fuel mega-firestorms, a south Asian nuclear war could result in an estimated 31 million casualties on the subcontinent.

The consequences of nuclear war would be global. Recent calculations of the dust,

particulates and smoke thrust into the atmosphere by as few as 100 nuclear weapons indicate that even a regional war could have major impact on the planet's climate. Enveloped in clouds that would reflect sunlight back into space, the Earth could enter a "nuclear winter" destroying food crops, triggering wide-spread starvation. Climatic anomalies could persist for a decade or more.

Neither these scenarios nor the continued spread of nuclear weapons are inevitable. Fewer countries have nuclear weapons or weapon programmes today than 20 years ago and nuclear arsenals have been cut in half during this period. More countries have given up nuclear weapons or weapons programmes in the past 20 years than have started them. Ballistic missile arsenals have similarly shrunk, resulting in a smaller, though still deadly, threat to the survival of mankind.

New initiatives to prevent nuclear terrorism, block proliferation and accelerate nuclear disarmament have been endorsed by senior conservative and liberal experts and officials, including by leaders of the United Kingdom and several U.S. presidential candidates. These efforts combine deep reductions in U.S. and Russian arsenals, bans on nuclear testing, halting the production of nuclear weapon materials, aggressive programs to secure and eliminate all weapon materials that could fall into terrorist hands and tough, new restrictions on the ability of new nations to acquire these weapons. With increased consensus on nuclear policy among experts and continuing political change in major nuclear powers, the prospects for an effective, comprehensive solution to nuclear weapons threats are better now than they have been for almost 15 years.

Nature

Cosmic Threats
Arnon Dar

The most violent stellar events in the Universe observed by astronomers at large distances may take place at sufficiently close distances to affect severely the terrestrial environment and even cause major mass extinctions on planet Earth. Such events include supernova (SN) explosions, long and short gamma ray bursts (GRBs), and eruptions of anomalous pulsars and microblazars. Their possible effects on the terrestrial environment and their direct threat to life will be discussed. The credibility of such threats will be tested by examining whether such violent astrophysical events could have been responsible for some of the major mass extinctions which took place on planet Earth and were documented relatively well in the geological records of the past 500 million years.

Hazards from Comets and Asteroids
William Napier

The idea that celestial bodies may on occasion strike the Earth with catastrophic consequences very likely pre-dates Christianity. Its history and current status are reviewed here from an astronomical perspective. The concept essentially died out in the 19th century following the Darwinian revolution, but was revived following the discovery of increasing numbers of small bodies in Earth-crossing orbits throughout the 1970s, and the realisation that high-energy impacts with such bodies are relatively common on geological timescales. The Oort comet cloud appears to yield most of the largest hazards (impact energies 10-100 million megatons equivalent of TNT). The cloud is sensitive to external perturbers, and these yield Galactic signatures in the impact cratering record of the past 250 million years, mainly in the form of discrete bombardment episodes recurring with a periodicity of about 36 Myr. We are in or near the peak of such an episode now. There is a weak correlation between these impact episodes and mass extinctions, and a stronger one with the creation dates of large igneous provinces on Earth. On timescales of historical rather than geological interest, extrapolation from 30 yr of observation suggests that prompt extinction of humankind is unlikely, but that horrendous damage on a continental or global scale is possible from impacts by stray bodies. However, such extrapolation is based on the assumption of statistical completeness, and this is open to challenge on several fronts. In particular the role of rare, large comets, and their modes of disintegration, remains uncertain, and passage through dust and other debris from a large, disintegrating comet has the potential to crash civilisation. Evidence exists that such debris from an erstwhile large, short-period comet, is trapped in a 7:2 orbital resonance with Jupiter and that the Earth encounters it every 2600-2800 years.

Cosmic Impacts: The Most Extreme Global Catastrophes
David Morrison

Cosmic impacts are now recognized as a major factor in the history of the Earth and other planets. They are also the most extreme example of globally catastrophic risks with high magnitude but low frequency. We began to understand this hazard with discovery that the KT mass extinction of 65 million years ago was caused by the impact of a 15-km-diameter asteroid or comet. The sensitivity of the biosphere to such a relatively small impact came as a surprise, and prompts us to ask whether other mass extinctions were also triggered by cosmic impacts, thus injecting a catastrophic element into evolutionary history. Similar studies of the frequency and environmental effects of impacts can be used to evaluate the contemporary hazard. We estimate the risk from impacts of different size, and discuss the Spaceguard Survey to discover and characterize potentially threatening near-earth-asteroids. This survey has already discovered and cataloged more than 80% of the most dangerous of these NEAs. Our current challenge is to evaluate technologies and consider the policy implications of efforts to protect our planet by deflecting future impactors before they hit. Although as scientists we now understand the nature of the impact threat, there is no global organization that has assumed responsibility for planning to mitigate future impacts.

Into the Dark: The Long Term Future of our Dying Universe
Fred Adams

This talk outlines astrophysical issues related to the long term fate of the cosmos. We consider the evolution of planets, stars, stellar populations, galaxies, and the universe itself over time scales that greatly exceed the current age of the universe. The discussion starts with the effects of accelerated cosmic expansion, which causes every galaxy cluster to become its own island universe in the near future. Next we discuss stellar evolution calculations that follow the development of the low mass stars (the most common stars) and consider the end of conventional star formation. We then determine the mass distribution of stellar remnants--the neutron stars, white dwarfs, and brown dwarfs remaining after stellar evolution has run its course. After several trillion years, the supply of interstellar gas grows depleted, yet star formation continues at a highly attenuated rate through brown dwarf collisions. This process tails off as the galaxy gradually loses its stars by ejecting the majority, and driving a minority toward accretion onto massive black holes. As the galaxy disperses, weakly interacting dark matter particles are accreted by white dwarfs, where they subsequently annihilate and keep the old stellar remnants relatively warm. After accounting for the demise of the galaxy, we consider the evaporation of expelled degenerate objects (planets, white dwarfs, and neutron stars). The evolution and eventual sublimation of these objects is dictated by the decay of their constituent nucleons. After white dwarfs and neutron stars have disappeared, the black holes are the brightest astrophysical objects, slowly losing their mass as they emit Hawking radiation. After the largest black holes have evaporated, the universe slowly slides into darkness.

Social, Scientific and Medical Lessons from the Great Influenza Pandemic of 1918
John Oxford

As we are approaching the 90th anniversary of the Spanish influenza there is a realization that much can be learnt to help us face the first global outbreak of the 20th century. SARS does not provide a realistic model, the virus being controlled by quarantine. Influenza is a much more dangerous virus. There was advance warning from small outbreaks in 1916 of a newly emerging infection but this information was ignored. The great wave in the autumn of 1918 saw acts of heroism in health care workers and in the community whilst the scientific community struggled to use masks and vaccines. Unexpectedly some quarantine studies were started in the USA to deliberately infect volunteers. With all this in mind, are we ready now to confront the most vicious virus known to us?

Biotechnology and Biosecurity: Preventing Risks While Preserving Benefits
Ali Nouri

Breakthroughs in biotechnology are providing tremendous benefits to health, food security, the environment, and alternative energies. But unless appropriately managed, these advances also facilitate the production of biological weapons. While these threats used to be confined to state-sponsored weapons programs, the revolution in biotechnology and life science research has placed powerful tools in

hands of small groups of the technically competent and even individuals. Scientists can now synthesize viruses de novo. This was demonstrated recently in experiments that re-engineered from scratch the extinct Spanish influenza virus—the agent that killed 50 million people in 1918. Other examples include rendering human pathogens like tuberculosis more resistant to antibiotics, or modifying viruses to evade natural host immunity. Although these experiments help elucidate how pathogens cause disease, in the wrong hands these tools could have catastrophic public health consequences. Conventional dogma holds that advances in biotechnology will inevitably increase dangers associated with nefarious use. We suggest that trends in biotechnology—particularly automation and centralization—actually provide opportunities for safeguards that minimize the risks, while ensuring that benefits are not hindered.

Unintended Consequences

Small Machines, Big Choices: The Looming Impacts of Molecular Manufacturing
Mike Treder and Chris Phoenix

Unlike most nanotechnologies, molecular manufacturing—a prospective new way to build powerful products atom by atom—likely will introduce global catastrophic risks. Although this near-future development also could bring many benefits, the dangers are great enough that some form of international regulation may be required. Among those dangers are a fast-moving arms race leading to global war, severe economic and social disruption, worldwide oppressive governance, environmental degradation, radically enhanced intelligences, and more. In assessing the above risks, a major variable is how long it will take to develop nanotechnology to a point of exponential distribution of molecular manufacturing. Because that is not yet known, further studies are urgently needed.

(Artificial) Intelligence: The Wild Card
Eliezer Yudkowsky

"Intelligence", being difficult to analyze, may be somewhat overlooked as both a positive and a negative force in the future of humankind. We should not forget that intelligence is responsible for human civilization to begin with; it may be hard to talk about, but that doesn't mean it's weak, or that we can afford to ignore it. Cognitive technologies play a hard-to-analyze role in global catastrophic risks and their management; I talk about this problem generally, and Artificial Intelligence in particular.

Probing the Improbable. Methodological Challenges for Risks with Low Probabilities and High Stakes

Rafaela Hillerbrand, Toby Order and Anders Sandberg

Some risks have extremely high stakes. For example, a worldwide pandemic or asteroid impact could potentially kill more than a billion people. Comfortingly, scientific calculations often put very low probabilities on the occurrence of such catastrophes. In this paper, we argue that there are important new methodological problems which arise when assessing global catastrophic risks and we focus on a problem regarding probability estimation. When an expert provides a calculation of the probability of an outcome, they are really providing the probability of the outcome occurring, given that their argument is watertight. However, their argument may fail for a number of reasons such as a flaw in the underlying theory, a flaw in their modeling of the problem, or a mistake in their calculations. If the probability estimate given by an argument is dwarfed by the chance that the argument itself is flawed, then the estimate is suspect. We develop this idea formally, explaining how it differs from the related distinctions of model and parameter uncertainty. We show how serious the problem can be when it comes to catastrophic risks and how best to deal with it, using the risk estimates from the Large Hadron Collider as a test case.

Climate Change, Catastrophe and Uncertainty

Dave Frame

Climate change represents a substantial risk to many people in both the developed and developing worlds. In recent years, people have begun discussing mechanisms through which these risks could be amplified many times, to the extent that climate change may present an existential risk to humanity. At the same time, such speculations lie sufficiently far outside the established corpus of scientific knowledge that many informed commentators lament the rise of such a "catastrophic climate change" discourse. In this talk I will review the evidence for such existential risks, and discuss this in the context of the uncertainty inherent in environmental modelling.