Nuclear physics

Taking serious risks seriously

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Risk management is not a new idea: miners once used caged canaries as methane detectors. But modern technologies have made worldwide catastrophes imaginable — disasters so dreadful that we demand proof-in-principle that they cannot happen. Failures at nuclear reactors and chemical plants (such as Union Carbide in Bhopal, India) can kill or endanger many thousands of people. So the old protocol for risk avoidance — try it once; if it turns out to be dangerous don't do it again — is no longer acceptable. For example, scientists working on the Manhattan Project seriously considered whether a nuclear explosion could release enough energy to ignite the Earth's atmosphere. Their theories said no, and history has proved them right. But do we know enough about genetic engineering to proceed safely, or could someone unwittingly (or even deliberately) create a plague worse than the Black Death? For now, it's the physicists who are under the spotlight. The worry is that a new particle accelerator could trigger an irreversible process that would destroy our planet. It is a fair concern: one that must be raised, and one that has been answered decisively by scientists in the United States[1] and in Europe[2].

This latest doomsday vision relates to a unique facility now being completed at Brookhaven National Laboratory (Fig. 1). At the Relativistic Heavy Ion Collider (RHIC), beams of highly charged gold or lead atoms (the heavy ions) travelling at relativistic speeds (99.95% of light speed) will speed in opposite directions around circular racetracks before colliding. RHIC is truly an atom smasher: nucleus–nucleus impacts, taking place thousands of times per second, will each produce thousands of secondary particles. These incredibly complex 'events' will be recorded by sophisticated detectors and analysed at supercomputers or farmed out to a world consortium of smaller computers. RHIC will study matter at densities and temperatures never seen in the laboratory. On a small scale, it will reproduce the extreme conditions that reigned in the early Universe, conditions under which the constituents of ordinary matter are expected to be liberated as a quark–gluon plasma. Physicists have long speculated about this state of matter, but RHIC may soon let them glimpse it.

Meanwhile, the media and a concerned public demand to know whether these experiments could have unforeseen adverse consequences. The root of their anxiety may

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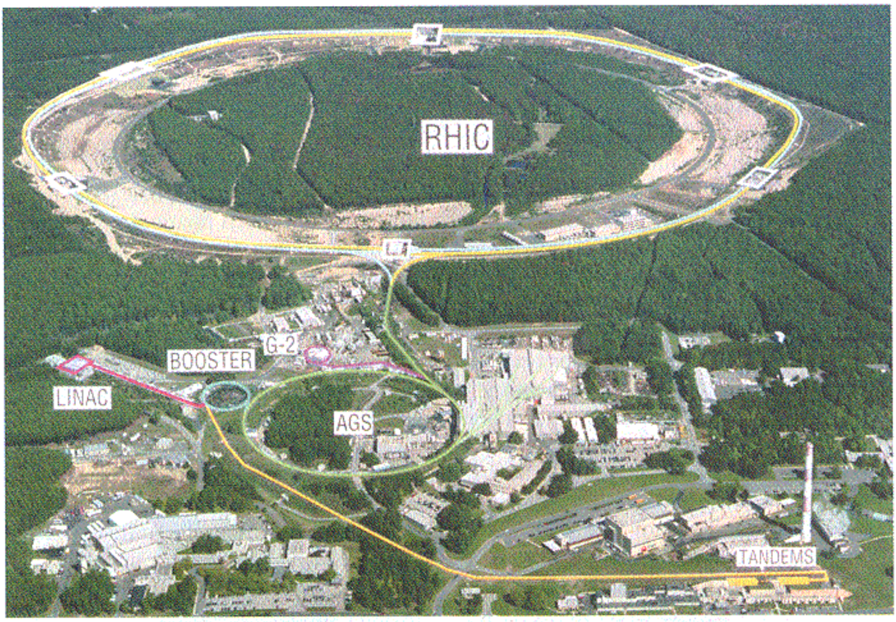

Figure 1 **Would RHIC wreck the world? Fears that the Relativistic Heavy Ion Collider at Brookhaven in the United States could trigger an unforeseen disaster have been allayed by new calculations[1,2] that show the risk of a worldwide catastrophe to be truly negligible.**

have been a comment by theorist Frank Wilczek in the July issue of *Scientific American*[3], which was picked up by a British newspaper. Later that month, the director of Brookhaven got together a panel of independent experts (including Wilczek) to investigate the reality behind the headlines. The report from Buzna *et al.*[1] identifies three conceivable disaster scenarios at RHIC: in which experiments produce 'black holes' that could gradually consume the Earth; a 'vacuum instability' that could expand catastrophically in all directions at the speed of light; or 'strangelets' — a stable kind of 'strange matter' — that would grow to incorporate ordinary matter, perhaps transforming the entire Earth into its form.

The first two issues have been raised, and dismissed, each time a new particle accelerator opens. Using similar arguments, Buzna *et al.* were able to conclude that neither poses any threat at RHIC. There is no chance at all that RHIC could manufacture a black hole or a gravitational singularity. Even if the RHIC (or its higher-energy successors) could create a black hole, it would be so tiny that it would evaporate instantly. Previous studies also argue against a vacuum instability, but cannot quite rule it out. In the natural world, relativistic heavy ions in the form of cosmic rays have been making RHIC-like collisions with one another in space for aeons (more, in fact, than will ever take place at RHIC). These distant collisions do not make RHIC experiments any less useful because they cannot be directly studied, but one fact is clear: cosmic-ray collisions in space have not led to the creation of a new vacuum, so we can breathe easily.

The third possibility is a new concern raised by the fact that RHIC accelerates heavy ions rather than individual elementary particles, and must be considered more carefully. This was done by Buzna *et al.*[1] and also by Dar *et al.*[2] at CERN in Geneva. Both groups include theorists who were among the first to speculate that lumps of strange matter called strangelets — which contain many strange quarks as well as the usual up and down quarks that make up atomic nuclei — might be more stable than ordinary matter. If strangelets exist (which is conceivable), and if they form reasonably stable lumps (which is unlikely), and if they are negatively charged (although the theory strongly favours positive charges), and if tiny strangelets can be created at RHIC (which is exceedingly unlikely), then there just might be a problem. A newborn strangelet could engulf atomic nuclei, growing relentlessly and ultimately consuming the Earth. The word 'unlikely', however many times it is repeated, just isn't enough to assuage our fears of this total disaster.

Neurobiology

The topography of

Howard Eichenbaum

For more than 40 years neuroscientists have explored the cerebral cortex with microelectrodes, recording the electrical activity of single neurons while 'tickling' them with different stimuli. Early investigators found that the cortical areas responsible for initial processing of sensory information yielded their secrets relatively easily[1,2] — for each area, a small set of simple sensory fea-