

answer is no. But many MOOCs do offer certificates of completion.

Yet because MOOCs are still relatively new, questions about certification, accreditation, and other concerns continue to be weighed and evaluated. The digital offerings present both threats and opportunities to institutionalized education; they are also changing the way we receive education and interact with fellow students and instructors. I believe that this movement will drive progress and leave some tradition in its wake.

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Letters

Serving science or serving politics

Among many big and small science meetings and workshops scheduled to take place around the world in 2014, two major ones are to be held in Russia's biggest and best-known cities. The biennial Scientific Assembly of the Committee on Space Research (COSPAR) is planned for August in Moscow. And the International Atomic Energy Agency's (IAEA's) Fusion Energy Conference, also convened every two years, is scheduled for Saint Petersburg in October.

The drive to hold those high-profile international scientific meetings in Russia, along with the 2014 Winter Olympic Games and the 2018 soccer World Cup, signifies the country's return to being a major player on the world stage, after two decades of reestablishing itself amid the ruins of the Soviet Union. At least, that is very much the intent.

It may not be an accident that the fields of human endeavor that have been chosen to represent the rebirth of Russia's ambition are sports and physical sciences, the two fundamentally peaceful vocations whose achievements were the subject of particular national pride back in the Soviet Union.

It is also of note that the Soviet Union initiated the space age by putting *Sputnik 1* in Earth's orbit, and it was the first country to fly a man, Yuri Gagarin, and later, a woman, Valentina Tereshkova, into space. Andrei Sakharov, who helped develop the Soviet hydrogen bomb and later became a human rights activist and Nobel Peace Prize recipient, was the one who conceived of the tokamak. Today the tokamak is the centerpiece of the world's magnetized fusion program, most notably represented by the

international experimental nuclear fusion reactor ITER, with which the IAEA has been actively involved from the beginning.

Does it appear as though there is a theme here? Unfortunately, Russia's ongoing military action in Ukraine and the intense crackdown on all Russian independent media are part of that same theme. Russia is reentering the world stage the only way its leader knows how: by going back to being an externally powerful and internally repressive nation with imperial ambitions. And neither communism nor socialism has anything to do with it.

We can leave it to the *New York Times* and the *Washington Post* to discuss the sociopolitical implications of Russia's actions. However, today I and many of my friends and colleagues, with and without Russian connections, have to decide whether to travel to and present at the 2014 COSPAR and IAEA conferences. Should we, can we, ignore the politics of it all? Is it okay to be a participant in the charade that the official trappings of the conferences are certain to become? Will we do more good by promoting the free exchange of scientific information or more harm by legitimizing the newly found ambitions of the Russian empire?

I have not yet made that decision for myself.

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A final note on the existence of event horizons

In his comment on Emil Mottola and Ruslan Vaulin's response (PHYSICS TODAY, November 2013, page 9) to his piece on black holes and information theory (PHYSICS TODAY, April 2013, page 30), Steve Giddings makes several statements that are simply wrong. From the point of view of quantum mechanics, black holes cannot exist because quantum mechanical evolution does not allow for the destruction of information and because black hole spacetimes do not provide a universal time.

As noted by Mottola and Vaulin, conflict with the information nondestruction principle can naturally be avoided if event horizons never form in the real world. Although Giddings is correct that this is an unpopular idea in the theoretical-physics community, the more interesting question for the general physics community is, What do as-

trophysical observations say about the existence of event horizons? As it happens, in contrast with what Giddings implies in his response to Mottola and Vaulin, at the present time there is no astrophysical evidence that event horizons exist in nature.

It is, of course, incontrovertible that compact objects exist whose size approximates the event-horizon radius predicted by classical general relativity. The pregnant issue is whether matter falling onto the surface of such an object encounters an event horizon where nothing remarkable occurs or whether it encounters a real surface. One might consider distinguishing an event horizon from a real surface by observing whether matter falling onto a compact object produces x rays. In fact, x-ray bursts from compact objects orbiting stars are dramatically smaller when the object's mass is greater than the maximum mass of a neutron star.¹ However, the bursts from neutron stars are due to the interaction of in-falling matter with stationary nuclear matter on the surface, and in no model for compact objects with a mass exceeding the maximum neutron-star mass is it possible for nuclear matter at the surface to be stationary.

In the case of compact objects bounded by a quantum critical surface, nucleons are transformed into leptons and gamma rays when they fall onto the surface. The destruction of baryons at the surface could provide a simple test as to whether the surface is an event horizon.² The observed spectrum of gamma rays from neutral pions produced by the interaction of cosmic rays with interstellar dust is symmetric about the mean boosted energy of the pions, reflecting the gamma rays' redshift or blueshift that results from the motion of the pions. However, if the pions are produced at the surface of a compact object, the redshifted component is absent, which results in an asymmetric gamma-ray spectrum—a distinct signature for the absence of an event horizon. The best opportunity for seeing this signal may arise from matter falling onto Sagittarius A*. Although the background of other gamma-ray sources in the central region of our galaxy makes it difficult to see this signature under ordinary circumstances, the Fermi Large Area Telescope may soon be able to detect the feature because of the infall of a gas cloud that is now approaching SgA*.

Matter falling onto the surface of a compact object also heats the object. However, in contradiction with the

paper quoted by Giddings³ in his response to Mottola and Vaulin, in the case of a massive object like SgA* the thermal radiation is far below the limits of reference 3 because the specific heat of compact objects with a quantum critical surface is enormously larger than the conventional values the researchers assumed.

References

1. D. Tournear et al., *Astrophys. J.* **595**, 1058 (2003).
2. J. Barbieri, G. Chapline, *Phys. Lett. B* **590**, 8 (2004); **709**, 114 (2012).
3. A. E. Broderick, A. Loeb, R. Narayan, *Astrophys. J.* **701**, 1357 (2009).

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■ **Giddings replies:** George Chapline's letter accurately notes that in the quantum context one must be careful about what one means by the horizon. Those working on quantum black holes have well appreciated that distinction. While true event horizons may be ill-defined in the quantum theory, an important, well-defined, semiclassical notion is that of an apparent horizon, or trapped surface, where light rays begin

to converge. This surface demarcates a region from which information cannot escape by local field theory propagation. The distinction between apparent and true horizons is a detail whose proper treatment in my article was precluded by space constraints.

Gravastars and other massive remnant variants replace the apparent horizon by a new kind of physical interface. Chapline fails to recognize that the admitted unpopularity of such scenarios stems from significant objections to their underlying physics. Those include, as outlined in my response to Mottola and Vaulin, the extreme form of nonlocality they apparently require—in contrast with the “minimal” nonlocality I have been recently exploring.

Although one would need more of a theory of such an interface to make sharp predictions, clearly, if stationary just outside the would-be horizon, that interface would be very highly boosted with respect to freely infalling matter. Thus it is a significant problem to explain why collisions of infalling matter with the interface don't lead to substantial outward scattering. Reference 3 of Chapline's letter places an observational bound that less than 0.4% of the

infalling energy is reradiated from a putative surface of Sagittarius A*, assuming surface thermalization. This illustrates how strong such bounds are, and the possibility of extending them to other radiation spectra. In particular, in Chapline's outlined scenario, one might also expect a significant fraction of accreted energy to be emitted. Although improved data are clearly welcome, I respectfully disagree with Chapline's statement that the bounds on observed energy radiated from a presumed surface present “no astrophysical evidence” for horizons.

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Early history of Arecibo Observatory

Thank you for the article “The Arecibo Observatory: Fifty astronomical years” by Daniel Altschuler and Chris Salter (*PHYSICS TODAY*, November 2013, page 43). I'd like to add a historical note.

The first publication to discuss using a spherical reflector set in the ground and steered by a line source, as illustrated

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