

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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