Cosmic entropy could be 100 times greater than previously thought

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(PhysOrg.com) -- A new analysis of supermassive black holes has discovered the entropy of the universe is much greater than previously thought, which means it may also be very slightly closer to ultimate heat death.

The study, analyzing measurements of the supermassive black hole mass function, was carried out by two Australian cosmologists: Chas A. Egan from the Australian National University in Canberra, and Charles H. Lineweaver from the University of NSW in Sydney. Their results indicated the entropy at the current cosmic event horizon is much greater than the entropy of the interior of the universe, and the total cosmic entropy is about 100 times greater than previous calculations.

Entropy increases as the number of ways the system can be arranged microscopically without changing the external appearance increases. Egan used the example of hot water being poured into a cold bath. Before the hot and cold water meet they are separate and orderly and the system has low entropy. When the hot and cold water are well mixed, the entropy is high and no heat flow between the two is possible.

Egan and Lineweaver found the collective entropy of the supermassive black holes was around 100 times higher than expected. Since these black holes contribute more to the entropy in the universe than anything else, the results imply that the entire cosmic entropy is also a 100 times greater than earlier estimates.

Previous calculations of the cosmic entropy assumed the presence of a 10 million solar-mass black hole at the center of each galaxy, and the entropy was calculated using an estimated average mass. Egan and Lineweaver had access to more recent data that gave them the range of supermassive black hole masses rather than an average. Egan said the study revealed a smaller number of larger supermassive black holes contribute much more to the entropy than previously believed.

The universe has much lower entropy than is theoretically possible, and this is still true, even with the new calculations. This is just as well because the entropy of the universe must be below the maximum theoretical value or life and other complex phenomena will cease to exist. As the entropy gradually increases it will eventually approach the theoretical maximum, a state many physicists have called the heat death of the universe. The new calculation takes the universe a little closer, but it is still only a billionth of a billionth of the maximum.

Not every scientist agrees that the higher entropy takes the universe closer to heat death. Ned Wright of the University of California in Los Angeles, for example, suggests the entropy is locked inside the supermassive black holes, and so the rest of the universe has lower entropy and is therefore further away from heat death.

More information: The paper was published online at arXiv.org.

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