What Is the Highest Possible Temperature?

2015-10-16 22:54:10 by Southern

As a black hole loses mass and surface area, it begins to radiate energy more rapidly, thereby heating up.

Temperature is a function of the movement of particles and is measured in a variety of scales including fahrenheit and celsius.

Michael Anissimov

There is no agreed-upon value, among physicists, for a maximum possible temperature. Under the current best-guess of a complete theory of physics, it is the Planck temperature, or 1.41679 x 1032 Kelvins. This translates to about 2.538 x 1032° Fahrenheit. Since the current theories of physics are incomplete, however, it is possible that it could be hotter.

The answer that a typical physicist gives to this question will depend on her implicit opinion of the completeness of the current set of physical theories. Temperature is a function of the motion of particles, so if nothing can move faster than the speed of light, then the maximum may be defined as a gas whose atomic constituents are each moving at the speed of light. The problem is that attaining the speed of light in this universe is impossible; light speed is a quantity that may only be approached asymptotically. The more energy that is put into a particle, the closer it gets to moving at light speed, though it never fully reaches it.

At least one scientist has proposed defining the maximum possible temperature as what someone would get if she took all the energy in the universe and put it into accelerating the lightest possible particle she could find as closely as possible to the speed of light. If this is true, then discoveries about elementary particles and the size/density of the universe could be relevant to discovering the correct answer to the question. If the universe is infinite, there may be no formally defined limit.

Even though infinite temperature may be possible, it might be impossible to observe, making it irrelevant. Under Einstein's theory of relativity, an object accelerated close to the speed of light gains a tremendous amount of mass. That is why no amount of energy can suffice to accelerate any object, even an elementary particle, to the speed of light — it becomes infinitely massive at the limit. If a particle is accelerated to a certain velocity near that of light, it gains enough mass to collapse into a black hole, making it impossible for observers to make statements about its velocity.

The Planck temperature is reached in this universe under at least two separate conditions, according to some theories. The first occurred only once, 1 Planck time (10-43 seconds) after the Big Bang. At this time, the universe existed in an almost perfectly ordered state, with near-zero entropy. It may have even been a singularity, a physical object that can be described by only three quantities: mass, angular momentum, and electric charge. The Second Law of Thermodynamics, however, insists that the entropy (disorderliness) of a closed system must always increase. This means that the early universe had only one direction to go — that of higher entropy — and underwent a near-instantaneous breakdown.

The second set of conditions capable of producing the Planck temperature are those occurring at the final moments of a black hole's life. Black holes evaporate slowly due to quantum tunneling by matter adjacent to the black hole's surface. This effect is so slight that a typical black hole would take 1060 years to radiate away all its mass, but smaller black holes, like those with the mass of a small mountain, may take only 1010 years to evaporate. As a black hole loses mass and surface area, it begins to radiate energy more rapidly, thereby heating up, and at the final instant of its existence, radiates away energy so quickly that it momentarily achieves the Planck temperature.

[Wise Geek]