Space plasmas share a secret

Superhot clumps of matter behave according to a surprisingly universal rule.

Alexandra Witze

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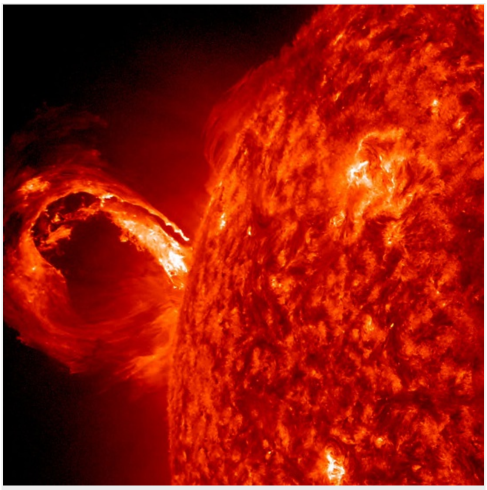
Physicists have discovered a fundamentally new way to describe how information and energy flow within plasmas — the seething hot seas of electrically charged particles that make up the Sun, other stars and much of the rest of the visible Universe.



NASA/SDO

Scientists have found a new way to describe the conditions that exist in space plasmas, the seas of electrically charged particles that make up the Sun.

The controversial idea comes from George Livadiotis and David McComas, two physicists at the Southwest Research Institute (SwRI) in San Antonio, Texas. They had been exploring basic parameters of different plasmas across the Universe, such as their temperature, density and the strength of their magnetic fields. From that information, the researchers calculated a new parameter, called *h**, that characterizes each plasma.

“We went into this thinking we’d find one value in one plasma, and another value in another plasma,” says McComas. “We were shocked and slightly horrified to find the same value across all of them. This is really a major deal.”

Livadiotis and McComas named *h** after a much more famous parameter, Planck's constant (*h*), which describes the smallest discrete unit of energy that a wave or particle can have according to quantum mechanics. But unlike the tiny Planck's constant, *h** applies to much bigger systems — perhaps even the entire Universe.

“We don’t touch the Planck constant, but we are saying that there is another such quantization that coexists with it, and is twelve orders of magnitude larger,” says Livadiotis. He presented the work at an SwRI colloquium in Boulder, Colorado, on 10 June. Details also appeared in March in the journal *Entropy*[1].

Group dynamics

The new unit describes the special conditions that exist in space plasmas, McComas says. The Sun’s corona, for instance, is a couple million degrees Celsius and roiled by magnetic fields. Under such extreme conditions, billions of electrically charged particles cluster together into loose groups. Particles within each group are linked, so the motion of one affects the motion of the entire group — but particles in different clusters are not linked. It’s as if several groups of teenagers are moving around a shopping centre, each group intensely focused on its own activities but ignoring the other, larger groups.

Using *h**, the authors have set out the minimum energy contained in each group of particles and the period of time for which that group exists.

“I really think George is on to something very significant,” says Nathan Schwadron, a space-plasma physicist at the University of New Hampshire in Durham who was initially sceptical. “The question at the moment is whether the idea is correct. I believe it is.”

Livadiotis and McComas want to extend their work to find out whether it applies to plasmas closer to home, such as those created in the laboratory. If so, *h** might turn out to be useful in developing plasma applications such as displays and lighting.

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References

1. Livadiotis, G. & McComas, D. *Entropy* **15**, 1118–1134 (2013).