

The Space Between: Changes in Plasma Affect Galaxy Clusters

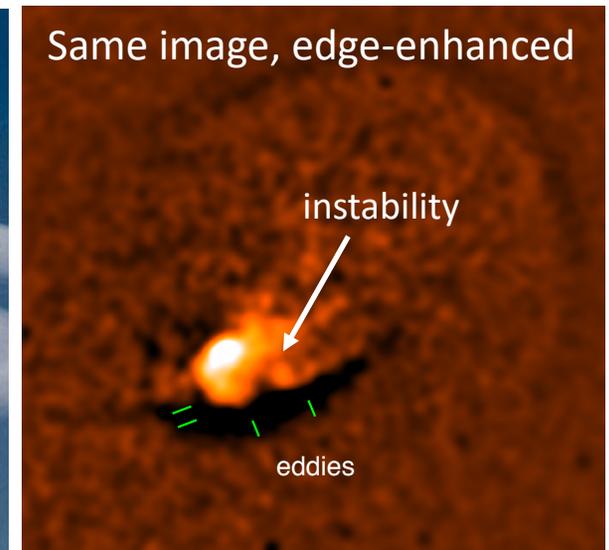
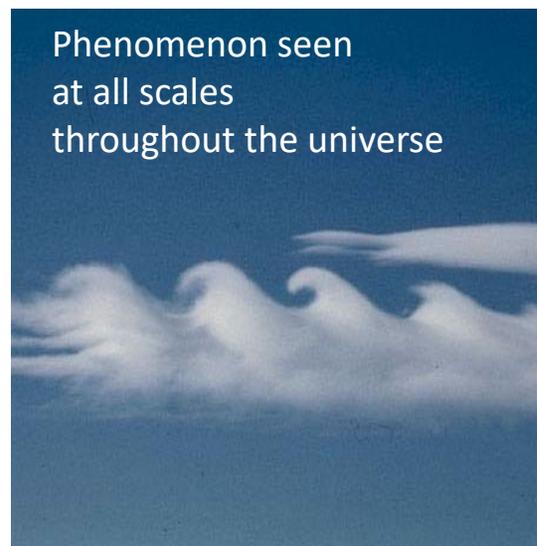
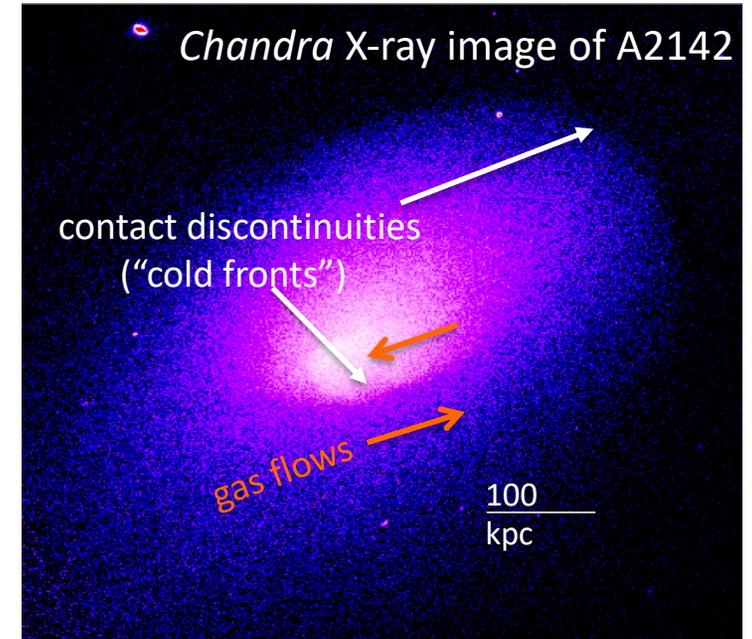
What is the science question? What are the physical properties of the plasma that exists between galaxies – which fills galaxy clusters and dominates the “ordinary” matter of the universe — in particular its *viscosity*?

What were your findings?

- Using a long Chandra X-ray observation of the galaxy cluster Abell 2142, we studied its prominent "cold fronts," or abrupt jumps in the density and temperature of the plasma.
- We found two eddies caused by opposing plasma flows. This is the most unambiguous detection of these eddies in a cluster to date.
- For these eddies to exist, plasma *viscosity* must be reduced, likely by weak magnetic fields which are nonetheless crucial for plasma microphysics.

What was the impact? Low plasma viscosity allows for galaxy stripping and gas mixing, which has big effects on galaxy cluster evolution.

Why does it matter? Scientists rely more and more on large computer simulations to model the universe. Observations of the physical properties of matter, like plasma between galaxies, are the basis for those simulations. The instabilities that we found in this galaxy cluster are observed throughout the universe — here on Earth in cloud formations, on Jupiter, in plasma that exists between stars, and in many other astrophysical systems.



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Qian Wang, Maxim Markevitch (662), 2018: “A deep X-ray look at Abell 2142 – Viscosity constraints from Kelvin-Helmholtz eddies, a displaced cool peak that makes a warm core, and a possible plasma depletion layer”, *Astrophysical Journal*