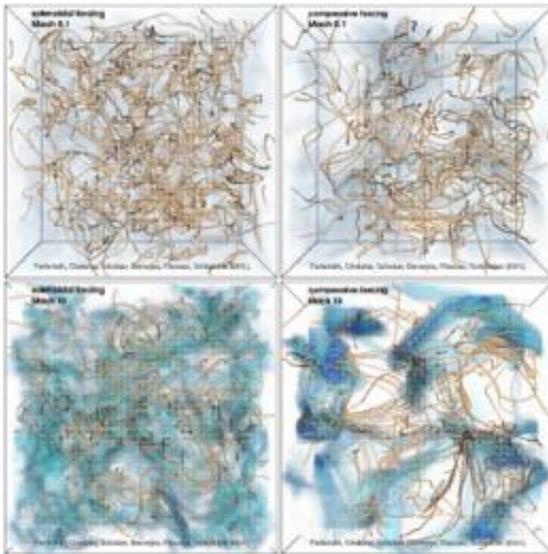


Did intense magnetic fields form shortly after the Big Bang?

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Turbulent structures of the magnetic field in four digital models representing significantly different physical conditions. For example, the interior of the Sun (top left) is not highly compressible and is characterized by subsonic flows, whereas the typical plasma of the primordial universe (bottom right) was very probably dominated by powerful compressive forces and highly supersonic turbulence. Credit: Federrath, Chabrier, Schober, Banerjee, Klessen, and Schleicher

Intense magnetic fields were probably generated in the universe shortly after the Big Bang, according to an international team led by Christoph Federrath and Gilles Chabrier of the CRAL (Centre de Recherche Astrophysique de Lyon, France). The project offers the first explanation

for the presence of intergalactic and interstellar magnetized gas. Published in the September 9, 2011 issue of *Physical Review Letters*, the researchers' findings shed light on the properties of the earliest stars and galaxies in the universe.

Why is the gas found between galaxies or between the stars of the same galaxy magnetized? An international team of astrophysicists has put forward the first potential explanation for this phenomenon: an initially weak magnetic field could have been amplified by turbulent motions, like those that take place within the Earth and the Sun, and which must have existed in the [primordial universe](#). "According to our simulations, this turbulence produced an exponential growth of the magnetic field," explain research leaders Christoph Federrath and Gilles Chabrier. "Our calculations show that this phenomenon is possible even under extreme physical conditions, such as those encountered shortly after the Big Bang, when the first stars formed."

Their 3D digital simulations reveal how [magnetic field lines](#) can be drawn out, twisted and folded by turbulent "flows." Just as electricity generates a magnetic field through the movement of charged particles, the charges themselves are subjected to a force as they move through a magnetic field. According to the [astrophysicists](#), "The interaction between a magnetic field and turbulent energy -- a kind of kinetic energy generated by turbulence -- can amplify an initially weak field, converting it into a strong field." The researchers hope that their work will shed light on the properties of the very first [stars and galaxies](#) to form in the universe.

More information: Mach Number Dependence of Turbulent Magnetic Field Amplification: Solenoidal versus Compressive Flows. C. Federrath, et al. *Physical Review Letters*. 9 September 2011.

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