Signs of ideal surfing conditions spotted in ocean of solar wind

August 31 2009

(PhysOrg.com) -- Researchers at the University of Warwick have found what could be the signal of ideal wave "surfing" conditions for individual particles within the massive turbulent ocean of the solar wind. The discovery could give a new insight into just how energy is dissipated in solar system sized plasmas such as the solar wind and could provide significant clues to scientists developing fusion power which relies on plasmas.

The research, led by Khurom Kiyanai and Professor Sandra Chapman in the University of Warwick's Centre for Fusion, Space and Astrophysics, looked at data from the Cluster spacecraft quartet to obtain a comparatively "quiet" slice of the solar wind as it progressed over an hour travelling covering roughly 2,340,000 Kilometres.

In space, on these large scales, and quiet conditions, nature provides an almost perfect experiment to study turbulence which could not be done on Earth in a laboratory. This plasma energy does eventually dissipate. One obvious way of understanding how such energetic plasma could dissipate this energy would be if the particles within the plasma collided with each other. However the solar wind is an example of a "Collisionless Plasma". The individual particles within that flow are still separated by massive distances so cannot directly interact with each other. They typically collide only once or twice with anything on their journey from the Sun to the Earth.

The University of Warwick Centre for Fusion, Space and Astrophysics

led team drilled down into the data on this 2,340,000 Kilometres zooming down to see how the turbulence works on these different length scales which might provide some clue as to how the plasma was able to dissipate energy.

When the researchers were able to make observations all the way down to about I kilometre they could resolve the behaviour of individual particles within the total 2,340,000 kilometres slice of solar wind. These regions, which held just one particle of the plasma, were themselves almost a kilometre in size. The researchers were surprised to see a new kind of turbulence on these small scales.

At this particular scale they saw that the levels of turbulence switched from being mutlifractal to single fractal pattern. This single fractal pattern turbulence appears just right to create and sustain waves that can interact with the individual particles in the solar wind. University of Warwick astrophysicist Khurom Kiyani said: "The particles in this "collisionless plasma" may too spread out to collide with each other but this could indicate that they can, and do, interact with waves and surfing these ideal waves is what allows them to dissipate their energy."

University of Warwick astrophysicist Professor Sandra Chapman said "We have been able to drill down through a vast ocean of data covering well over two million kilometres to get an insight in to what is happening in an area about the size of a beach, and on all length scales in between. We believe we are seeing waves on that beach that are providing the ideal surfing conditions to allow plasma particles to exchange energy without collisions."

Professor Sandra Chapman also said "These results are not just an interesting piece of astrophysics as the work has been led by a 'Centre for Fusion, Space and Astrophysics' the results have also immediately come to the attention of our colleagues working to increase the stability

of plasmas involved in the generation of fusion energy. Turbulence is a big problem in keeping the hot plasma confined long enough for burning to take place to generate fusion power."

More information: The research entitled Global Scale-Invariant Dissipation in Collisionless Plasma Turbulence has just been published in *Physical Review Letters.*

Source: University of Warwick (news : web)

Citation: Signs of ideal surfing conditions spotted in ocean of solar wind (2009, August 31) retrieved 19 April 2024 from
https://phys.org/news/2009-08-ideal-surfing-conditions-ocean-solar.html

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