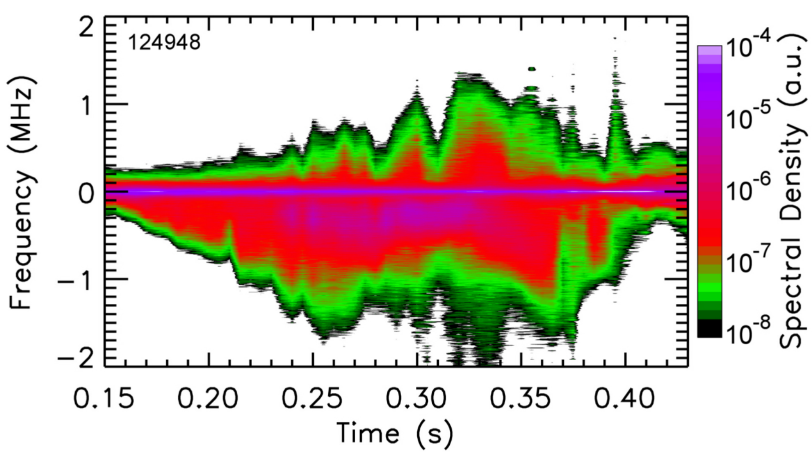
FOR IMMEDIATE RELEASE

Identified Source of Small-Scale Plasma Turbulence

PRINCETON, New Jersey, October 1, 2008 – Measurements on the National Spherical Torus Experiment (NSTX) of Princeton University have revealed the existence of turbulent fluctuations with a scale of the order of the electron gyroradius. Experimental observations and agreement with numerical results support the conjecture that the observed turbulence is driven by the electron temperature gradient.

The minimum size of a fusion reactor is set by its capability to retain the energy of charged fusion products – α-particles – for a time long enough to balance the inevitable energy losses and become self-sustaining. This is why understanding the mechanism of energy transport in tokamaks is one of the great challenges of fusion research.

The causes of the loss of electron energy in magnetically confined plasmas are still an outstanding problem. This is the most worrisome since in a fusion reactor, a large fraction of the energy of α-particles will be released directly to the electrons. Various theories and numerical simulations support the conjecture that anomalous electron transport may arise from small size turbulent eddies driven by spatial variations of the electron temperature. Confirming that this is indeed the case would allow for operation of fusion devices in ways that minimize the loss of electron energy.



Frequency spectrum of small-scale turbulent fluctuations

Until recently, there was no direct proof of the existence of this turbulence. Fortunately, new experiments on NSTX plasmas have detected this type of turbulent fluctuations using an advanced microwave scattering system [1]. An example is illustrated in the attached figure, showing the time evolution of the frequency spectrum of turbulent eddies with a size of approximately 2 mm. That the electron temperature gradient is the source of these fluctuations was confirmed by numerical results from a stability code, indicating the onset of plasma instability when the temperature gradient exceeds a critical threshold.

Additional experiments have found that in regions of plasma where under certain conditions the outwards flow of energy becomes very small – a transport barrier – the level of turbulence is very small. These observations could represent the Rosetta Stone for the explanation of electron thermal losses in magnetically confined plasmas.

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[1] Mazzucato, E. et al., Phys. Rev. Lett, **101** (2008) 075001.

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