Bringing the stars down to earth is one of the great scientific challenges of the 21st century. The controlled fusion of isotopes hydrogen into helium represents an essentially inexhaustible source of energy for society and remarkable progress has been made in attaining that goal by building new understanding of the still mysterious conditions inside the tokamak, the experimental test bed where fusion reactions occur at temperatures exceeding 100 million degrees. The ITER tokamak, currently under construction in France, is designed to deliver 500 megawatts of output from 50 megawatts of input power for several minutes at a time. Success would open the door to a large-scale source of continuous power with no carbon emissions or hazardous waste problems, and fuel that could largely be extracted from ordinary seawater. Work on existing tokamaks is largely focused on the grand challenges of fusion: the need to contain an ongoing fusion reaction, create a stable “burning plasma” that can maintain its own temperature, and capture its massive heat output for electric power generation. Containing a stable plasma at high temperatures is a challenge because the fusion plasma supports many waves and instabilities, some leading to turbulence, which very effectively redistributes heat and particles in the plasma, inhibiting attainment of parameters needed to achieve a burning plasma. Advanced simulations are being used to make predictions about turbulence parameters, the predictions are being compared to results from newly developed plasma turbulence diagnostics, and models of plasma confinement and performance are being developed that steer the experimental optimization of plasma confinement and control. This talk will introduce basic plasma physics behind fusion energy development, discuss science and technologies of the leading fusion plasma confinement device, the tokamak, and will describe recent advances in understanding turbulent transport from MIT’s Alcator C-Mod tokamak.

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4:00-5:20 PM
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