Institut Spatial de McGill

McGill Space Institute

SEMINAR SERIES

Why Material From Enceladus' Ocean Keeps Getting Ejected Into Space

Edwin Kite

University of Chicago

Spacecraft observations suggest that the plumes of Saturn's moon Enceladus draw water from a subsurface ocean, but the sustainability of conduits linking ocean and surface is not understood. Observations show sustained (though tidally modulated) fissure eruptions throughout each orbit, and since the 2005 discovery of the plumes. Peak plume flux lags peak tidal extension by ~1 radian, suggestive of resonance.

Here we show that a model of the tiger stripes as tidally- flexed slots that puncture the ice shell can simultaneously explain the persistence of the eruptions through the tidal cycle, the phase lag, and the total power output of the tiger stripe terrain, while suggesting that the eruptions are maintained over geological timescales. The delay associated with flushing and refilling of O(1) m-wide slots with ocean water causes erupted flux to lag tidal forcing and helps to buttress slots against closure, while tidally pumped in-slot flow leads to heating and mechanical disruption that staves off slot freeze-out. Much narrower and much wider slots cannot be sustained. In the presence of long-lived slots, the 10ˆ6-yr average power output of the tiger stripes is buffered by a feedback between ice melt-back and subsidence to ~5 GW, which is equal to the observed power output, suggesting long-term stability. Turbulent dissipation makes testable predictions for the final flybys of Enceladus by the Cassini spacecraft.

Our model shows how open connections to an ocean can be reconciled with, and sustain, long-lived eruptions. Turbulent dissipation in long-lived slots helps maintain the ocean against freezing, maintains access by future Enceladus missions to ocean materials, and is plausibly the major energy source for tiger stripe activity.

Tuesday Dec 1, 3:30 pm

MSI Conference Room, 3550 University