EAPS Planetary lunch Colloquium Series (PICS)

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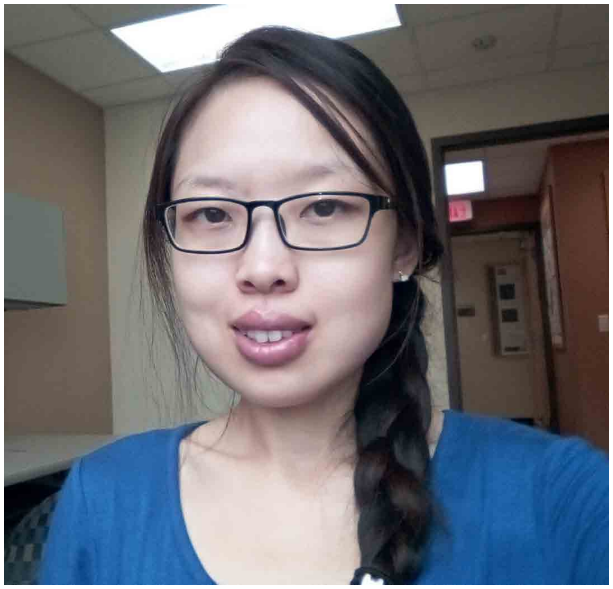
Enceladus: three-stage limit cycle and current state



Enceladus is one of the most popular worlds that might accommodate life outside our own earth. We study its evolutionary path, especially focusing on the physical processes that drive Enceladus to its current state. I will also discuss possible applications of these physical processes to other bodies in our solar system. Below is a brief summary of the evolution path for Enceladus.

Eccentricity (e) growth as Enceladus migrates deeper into mean motion resonance with Dione results in increased tidal heating. As the bottom of the ice shell melts, the rate of tidal heating jumps and run-away melting ensues. At the end of run-away melting, the shell's thickness has fallen below the value at which the frequency of free libration equals the orbital mean motion and e has damped to well below its current value. Subsequently, both the shell thickness and e partake in a limit cycle. As e damps toward its minimum value, the shell's thickness asymptotically approaches its resonant value from below. After minimum e, the shell thickens quickly and e grows even faster. This cycle is likely to have been repeated multiple times in the past.

Currently, e is much smaller than its equilibrium value corresponding to the shell thickness. Physical libration resonance resolves this mystery. It ensures that the low-e and medium-thickness state is present for most of the time between consecutive limit cycles. It is a robust scenario that avoids fine tuning or extreme parameter choice, and naturally produces episodic stages of high heating, consistent with softening of topographical features on Enceladus.

For more information, contact John Biersteker (jo22395@mit.edu)

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