The Identification of Non-Axisymmetric Features in Cassini Low-Resolution, High-Phase Images of Saturn's E Ring

J. W. Weiss[1,2], C. C. Porco[1] and C. J. Mitchell[1], [1]CICLOPS/SSI, 4750 Walnut St, Suite 205, Boulder, CO 80301 (weissj@issops.org) [2]Carleton College, One N College St, Northfield, MN 55057

Introduction: While the Cassini spacecraft was in Saturn's shadow in 2006, the imaging team acquired extremely high-phase, low-resolution images of the moon Enceladus and the E ring in which it is embedded. In the E ring near Enceladus, bright tendril-like as well as scalloped features were seen. We investigate the possibility that some or all of these features are streams of particles arising from the south polar jets of Enceladus and extending tens of thousands of kilometers into the E ring, merging with and adding to it. Using Cassini high resolution imaging data, [1] has identified approximately 100 jets distributed across the south polar terrain of the moon; the source locations on the surface and tilts of these jets have also been determined. With a 3D model for all the jets now in hand, we attempt assignments of both tendril and scallop features to individual jets. Successful matches will not only help determine which jets are the most powerful, but will allow a measure of the mass flux of jet particles into the E ring.

Method: We have developed a dynamical model to track particle motion from the surface of Enceladus into the E ring. We integrate the motions of individual particles using a fourth-order Runge-Kutta scheme. Our model includes the gravities of both Saturn and Enceladus, including the J_2 moments of each body. Because particles forming Enceladus' jets are of order a few microns in size [2], we must also include the possibility of particle charging and the consequent effects of Saturn's magnetic field. We include magnetic field terms up to the octupole moment. Particles are assumed to be uncharged upon leaving Enceladus and are then rapidly charged by a variety of currents – ranging from thermal and hot electrons to photocurrents [3]. Our model intrinsically includes variations in charging timescales (which scales as 1/r) for different particle sizes so that very small particles are charged on timescales comparable to the timescale for formation of tendrils and scallops. Because particles are small and the jets are tenuous, particles do not get close enough to interact with each other.

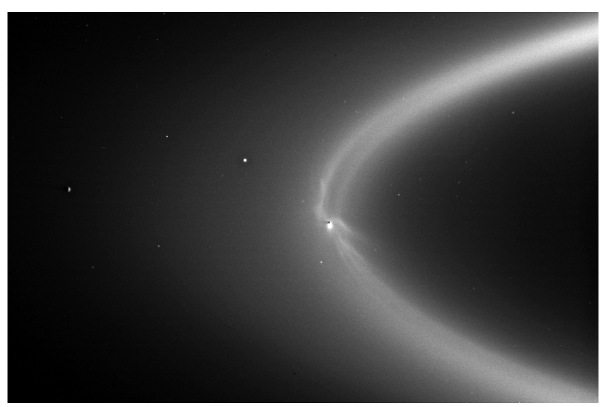
We begin with a handful of jets that are believed to be the most robust [1] and use their source locations and tilt directions to choose initial launch conditions. For each jet used as an input source, a spray of particles is launched and tracked from the jet's surface location, each particle having a direction near the jet's measured tilt and speeds selected from an exponential distribution found to be the best match by Ingersol and Ewald [2].

We turn the resulting tracks into synthetic images that we can compare with the actual images taken by Cassini. Synthetic images are produced by projecting the track of each particles onto the observer's sky-plane, weighting the brightness in each synthetic pixel by the particle's residence time in the pixel and by a phase function determined by the Sun-particle-observer angle.

Results: We have found that for particles smaller than ~1 micron, the influence of Saturn's magnetic field causes the resulting structures to blur out and not produce coherent tendrils as seen in our images. However, for larger particles, ~3 microns, distinct tendril and scallop features are produced. We will report on our efforts to match individual non-axisymmetric features in the Cassini WAC image with either the locus of E ring particles perturbed by Enceladus or the particles coming from individual jets.

References:

[1] Porco. C. C., et al (2012) Fall AGU 2012, Abstract #P13F-02 [2] Ingersoll, A. P., Ewald, S. P. (2011) *Icarus* 216, 492–506 [3] Horányi, M. (1996) Annu. Rev. Astron. Astrophys. 34, 383–418.



Enceladus' bright plume, long linear tendrils, scallops and Saturn's E ring, as imaged by the Cassini wide-angle camera in September 2006.