

# Explaining Saturn Ring Textures with a Predator-Prey Model

LW Esposito<sup>1</sup>, S Madhusudhanan<sup>1</sup>, P Madhusudhanan<sup>1</sup>, M Rehnberg<sup>1</sup>, Z Brown<sup>1</sup>

<sup>1</sup>LASP, University of Colorado

3665 Discovery Dr, Boulder, CO 80303-7820.

[larry.esposito@lasp.colorado.edu](mailto:larry.esposito@lasp.colorado.edu)

## Abstract

The textures seen in Saturn's Rings by Cassini can be explained by variations in the nature of embedded structures in the rings, including boulders, transient and driven self-gravity wakes.

## Introduction

The highest spatial resolution observations of Saturn's rings show a variety of textures (clumpy, feathery, streaky, see Tiscareno and Modesto 2018). Because numerical simulations cannot yet capture all the relevant physics, the multiple spatial scales or the asymptotic behavior at long time scales, we apply a simpler model of a predator-prey system.

## Textures

seen in the highest resolution Cassini ring images may arise from the same processes that give rise to self-gravity wakes, straw and ghosts in the Cassini UVIS occultations. We model these non-linear dynamics with an ecological analogy. In this model we include ring particles and their aggregates. The aggregate mass is the 'prey' (it would grow without limit if the relative velocity is unchanging) and the ring particle velocity dispersion is the 'predator' (it feeds off the prey, reducing them by erosive collisions).

## Results

**1.** We explain self-gravity wakes as the equilibrium fixed point of the predator-prey model, creating the **feathery structure**. **2.** Resonant forcing creates transients that are large enough to be seen in the Cassini images, which are called **straw**. **3.** Propeller

objects arise from accretive collisions. These propellers can create ghosts that explain the **streaky** structure seen in Cassini Grand Finale images of Saturn's C ring plateaus. **Initially**, structures are round, the longer-lived textures are sheared by differential rotation, and those due to persistent objects are azimuthally symmetric like the 'propellers' and 'ghosts'. Thus the different textures show the ages of the various features: Streaks (oldest) are from boulders that form ghosts; Straw is from driven transient aggregates; Feathery structure (most ephemeral) is the natural frequency response of the predator-prey feedback. The sharp boundaries between these regions are explained by a variation in the population of embedded objects, whose own gravity drives the clumping and forces the relative velocity, thus determining the lifetime of the structures. Because the dispersion relation we commonly use for density waves does not include these clumps, density wave analysis may not sense their presence.

## Reference

**Matthew S Tiscareno**, SETI Institute Mountain View, Mountain View, CA, United States and Jesse Modesto, California State Polytechnic University Pomona, Pomona, CA, United States  
[P43B-05 Radial distribution of textures in Saturn's main rings](#). Paper presented at 2018 Fall AGU Meeting, Washington DC.