Impact of Self-Gravity at the Encke Gap Edge

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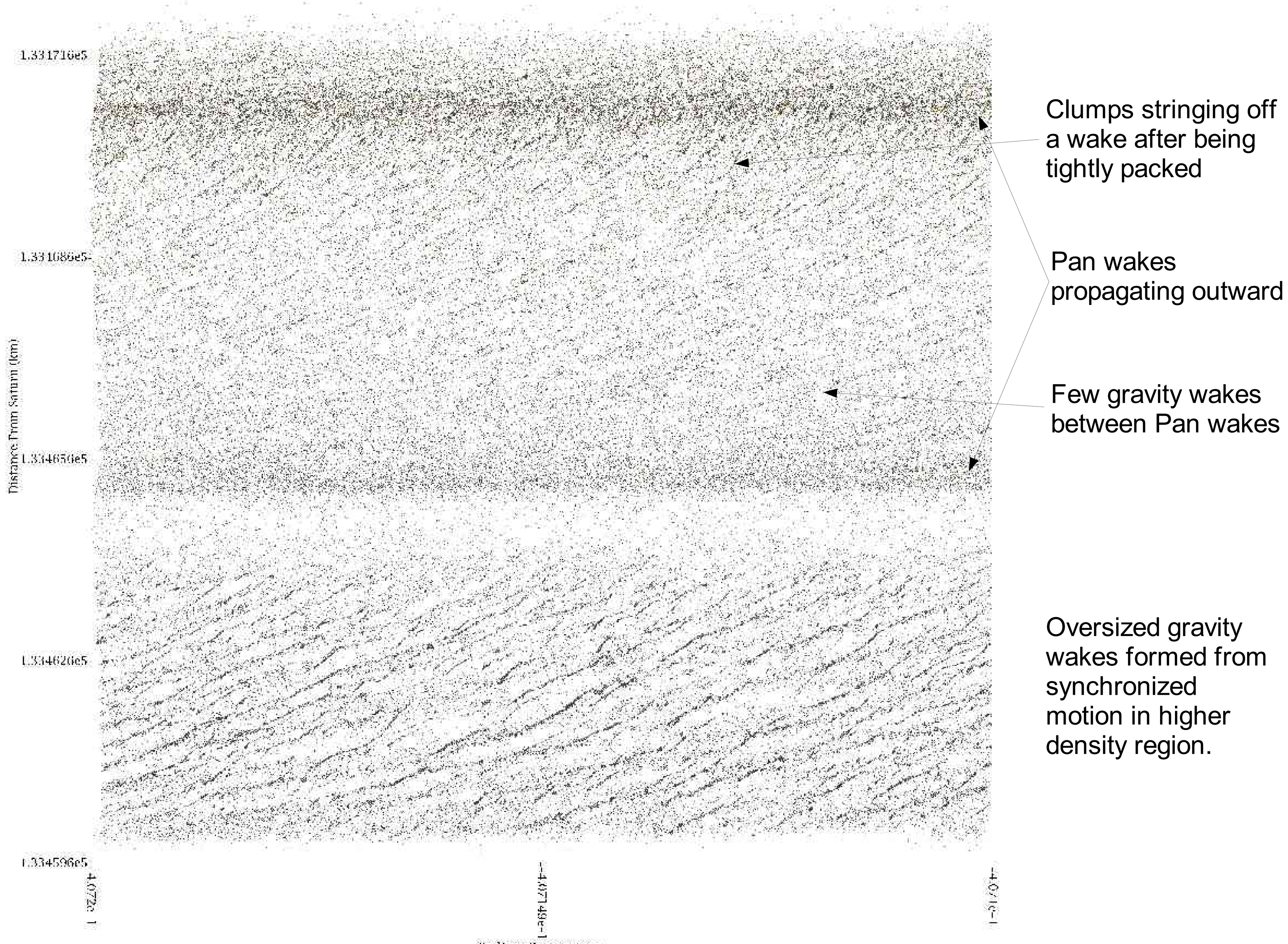
Abstract

We present the results of several numerical simulations of the outer edge of the Encke gap that include collisions and particle self-gravity. There are a number of significant interactions between the moon-induced wakes and the gravity wakes. In this poster we focus primarily on features that form at the edge of the ring, how those features might evolve over multiple synodic periods, and how these various features might appear in Cassini observations. The primary features seen in the edge region include a thickening of material that appears to fuel an increase in the strength of the gravity wakes. In our simulation, the gravity wakes are seen to grow as long as 3-km in length, more than 10 times longer than normal. These structures form as the particles move out into the gap after the moon wakes produce a high-density region. They are destroyed and re-form as the ring particles move along the wavy edge of the gap.

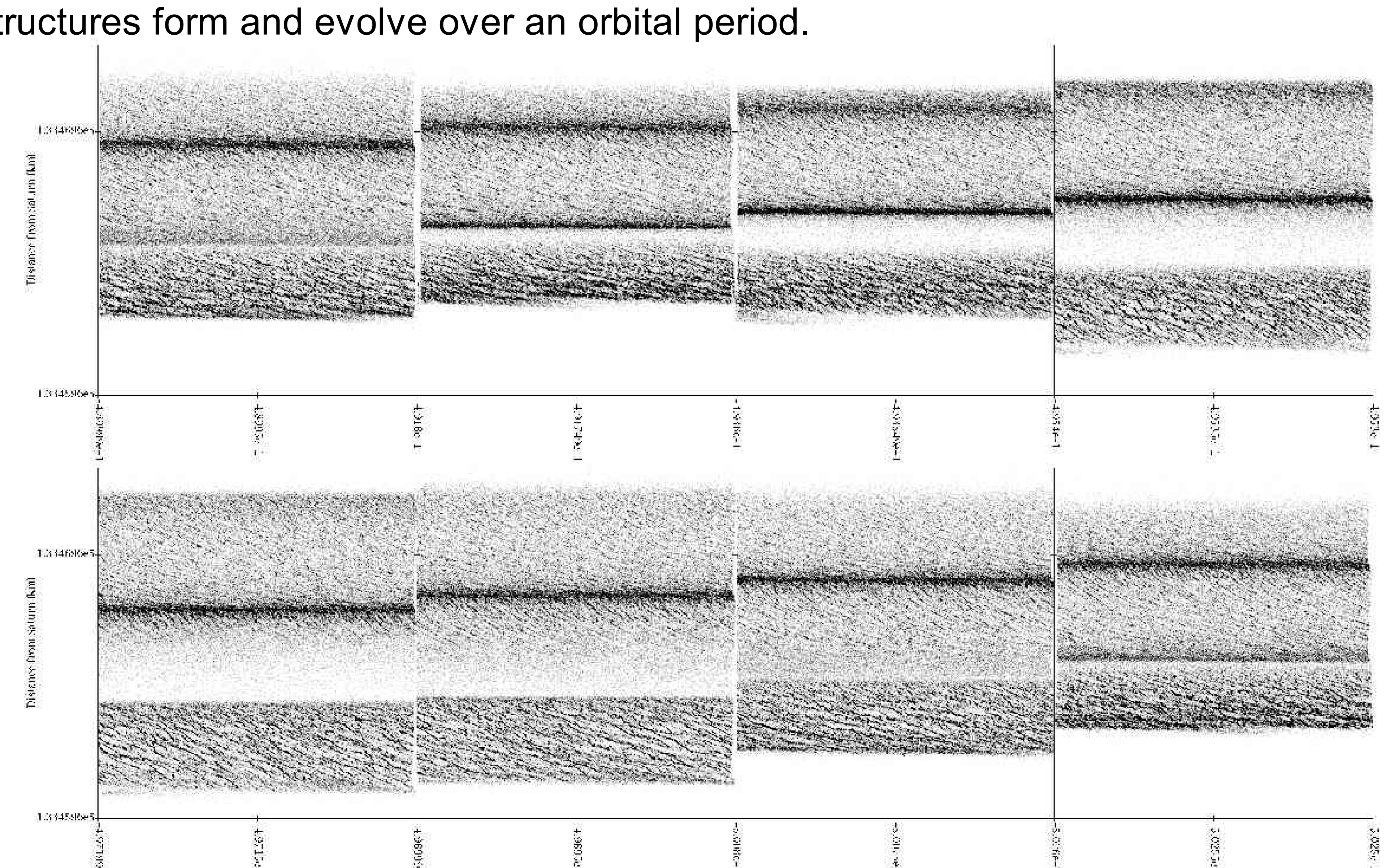
Annotated Simulation Cell

This figure shows a detailed view of one frame of simulation C. The major features are labeled to help you understand what is happening in these simulations.



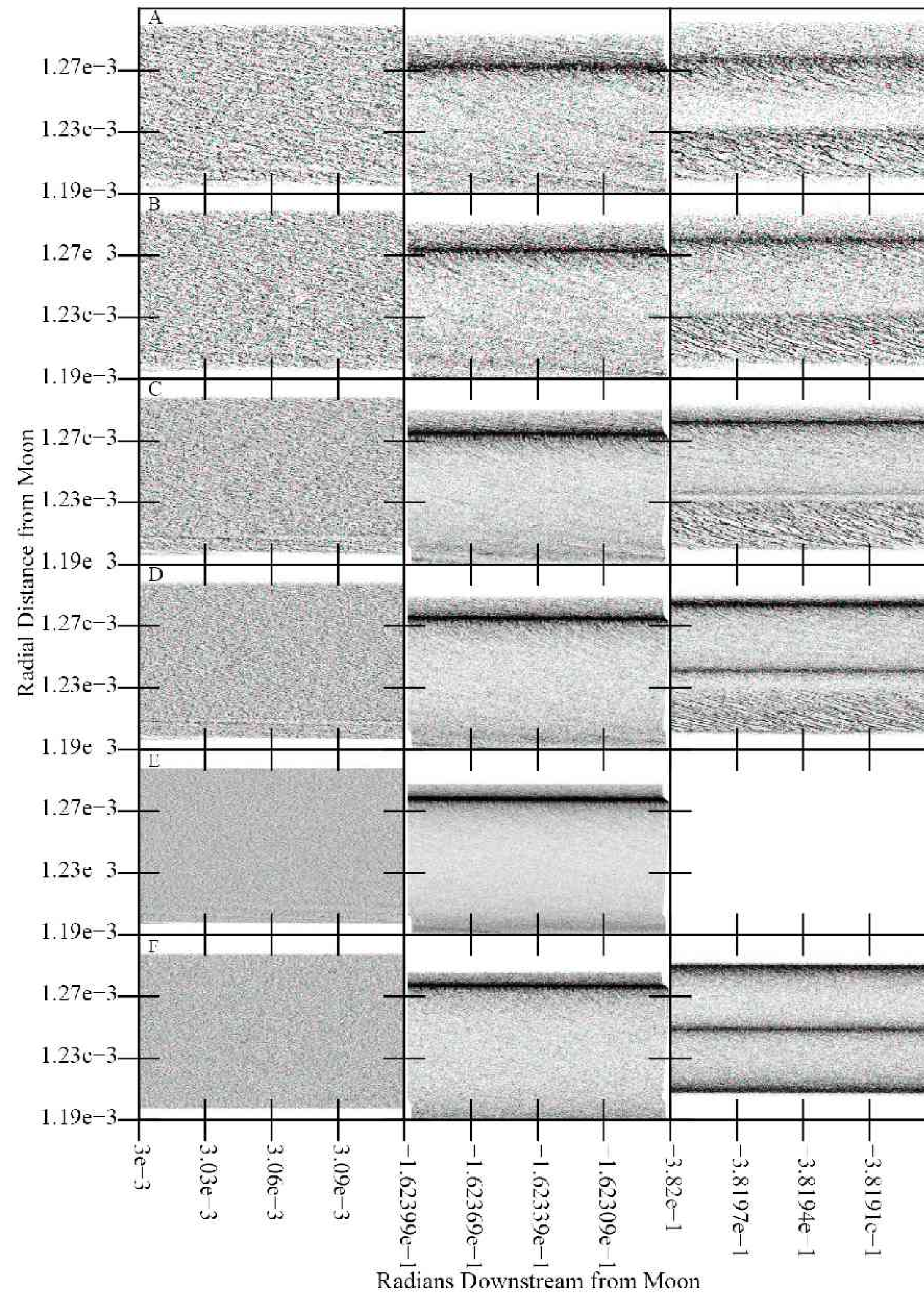
Detailed Time Sequence

These figures from the same simulation that was shown above illustrate how these structures form and evolve over an orbital period.



Different Systems

These figures show the behavior of several different systems at different points in the simulation. All the simulations shared an optical depth of 0.127. Next to each row of figures is the number of particles, internal particle density, and average surface density of the simulation. Measurements from Voyager images gives surface densities in the A ring between 26±10 and 96±40 g/cm^2



Particle Count: 62500
Particle Radius: 10.64m
Internal Density: 0.7g/cm^3
Surface Density: 124.6g/cm^2

Particle Count: 62500
Particle Radius: 10.64m
Internal Density: 0.5g/cm^3
Surface Density: 89.0g/cm^2

Particle Count: 250000
Particle Radius: 5.32m
Internal Density: 0.7g/cm^3
Surface Density: 62.3g/cm^2

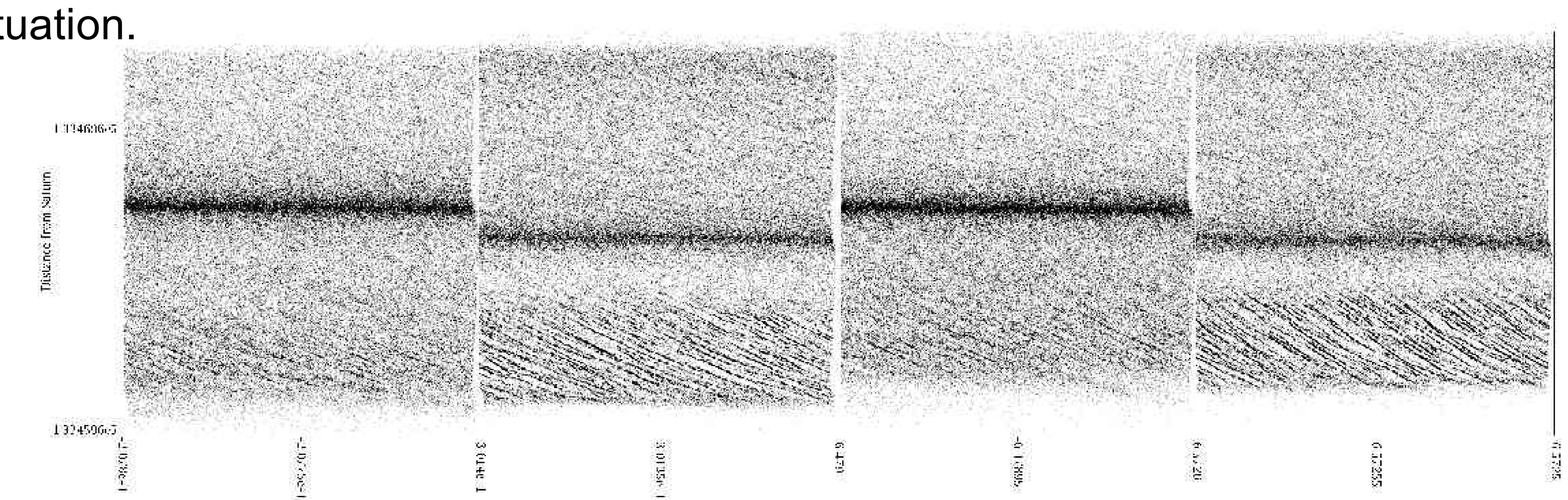
Particle Count: 25000
Particle Radius: 5.32m
Internal Density: 0.5g/cm^3
Surface Density: 44.5g/cm^2

Particle Count: 1000000
Particle Radius: 2.66m
Internal Density: 0.5g/cm^3
Surface Density: 22.3g/cm^2

Particle Count: 25000
Particle Radius: 5.32m
Internal Density: 0.0g/cm^3
Surface Density: 0.0g/cm^2

Multiple Synodic Periods

Recently we performed a simulation that ran for more than one synodic period. This simulation involved 125,000 particles each with a radius of 7.5 m and internal density of 0.5 g/cm^3 giving a surface density of 62.9 g/cm^2 and maintaining the same geometric optical depth of the other simulations. These figures show that simulation during the first and second synodic periods at similar distances after the moon encounter. Unfortunately, that choice of conditions resulted in a weaker edge effect that was not compounded with a second pass by the moon. We are currently extending simulation C beyond a synodic period to see if the effected region grows or strengthens in that situation.



Conclusions

Gravity and moon wakes can potentially interact in complex ways in planetary rings. The the types of structures that we see in these simulations have been seen in some of the early Cassini images. The behavior of these features is strongly impacted by the nature of the particles in the ring so it is possible that it could be a useful diagnostic if observations can be compared to a sufficiently broad sampling of simulations.

Icarus Paper – many of the results shown here appear in a paper recently accepted to Icarus. If you would like a preprint of that paper, please ask and we can provide you with one.