Propellers in Saturn's rings

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Propellers: traces embedded bodies

N-body simulation (w/o SG)

Bleriot: the largest known trans-Encke propeller.

(N1586641169 and N1586641255, 3km/pixel, lit geometry)
Bleriot: Zet Per R42 occultation

Very dominant gap (even compared to dens. w.)
Bleriot: Zet Per R42 occultation

Possible interpretation: a gap + flanking wakes
Statistical significance of features

- Voyager Uranus data & Cassini F ring: M test based on Poisson statistics (J. Colwell)

- But: **M test is not applicable** to main rings (microstructure changes significantly statistics, e.g. excess variance and autocorrelations)

- T-test: do two data sets have same mean or not?

\[
T = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{\sum_{i=0}^{N-1} (x_i - \bar{x})^2 + \sum_{i=0}^{M-1} (y_i - \bar{y})^2}{N + M - 2} \left( \frac{1}{N} + \frac{1}{M} \right)}}
\]
Bleriot motion: linear fit around Zet Per

![Graph showing residual to circular orbit in kilometers over time with annotations for 1st sine, 1st + 2nd sine, and Zet Per R42 occ.]
Bleriot: resulting Zet Per geometry

Zet Per R42 egress occultation of Bleriot (dL0=−85.3186km)

Radial coordinate relative to Bleriot [km]

Azimuthal coordinate relative to Bleriot [km]

Zet Per R42
Gap position
Zet Per geometry: hi-res ISS example
Bleriot: Zet Per R42 occultation

Interpretation: a gap + 2 flanking wakes
Zet Per vs Bleriot geometry uncertainty

- Occ $dR \leq 0.5\text{km}$ (ring edges) ($\sim 100\text{ms}$ down-the-track)

- Occ $dL$???
  pessimistic $10 \times dR \leq 10\text{km}$

- Bleriot $dR \leq 50\text{m}$ (mean motion very precise)

- Bleriot $dL \leq 10\text{km}$ (max scatter)
Stewart (1991) simple wake model $R_{\text{Bleriot}} = 200\text{m}$ predicts too many wakes!

Bleriot in Zet Per: wake model

Moonlet radius $R = 200\text{m}$

1st wake

2nd wake

+ ERROR

Relative radial coordinate [km]

Relative azimuthal coordinate [km]
Bleriot in Zet Per: wake model

\[ R_{\text{Bleriot}} = 800 \text{m} \text{ predicts too few wakes!} \]
Bleriot in Zet Per: wake model

Moonlet radius $R=400\text{m}$

$R_{\text{Bleriot}} = 400\text{m}$ looks like a possible solution
Bleriot new detection: Alp Lyr R175
Bleriot new detection: Alp Lyr R175

Alp_Lyr_R175 (ingress), 1ms, 2012-324T07:46, B=35.2°, Δr=−3.1m, #=10150

GAP

Flanking Wake?
P~10%
Bleriot new detection: Alp Lyr R175
Bleriot @ Alp Lyr R175: UVIS vs VIMS
Bleriot motion:

- 2 harmonics fit
- Final residual still has a pattern.

Residual to circular orbit

Residual to circular orbit + 1 sine

Residual to circular orbit + 2 sines

Final residual still has a pattern.
Bleriot motion: 3 harmonics fit

Residual to circular orbit

Residual to circular orbit + 1 sine

Residual to circular orbit + 2 sines

Residual to circular orbit + 3 sines
Summary

- 2 UVIS (+1 VIMS) occultation of Bleriot
- Bleriot shape: gap + wakes.
- Images show propeller wakes.
- Bleriot embedded body of ~400m in size. Consistent with other estimates!
- 2 sines fit to Bleriot motion: 2400km + 230km amplitudes (30km rms). 3rd sine with 40km amplitude leaves rms<20km.