A Prominent m=1 Standing Wave in the Cassini Division – and New Insights into the "Flynn & Cuzzi Bands"

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Planetary Rings Workshop – CU-LASP, Boulder, CO

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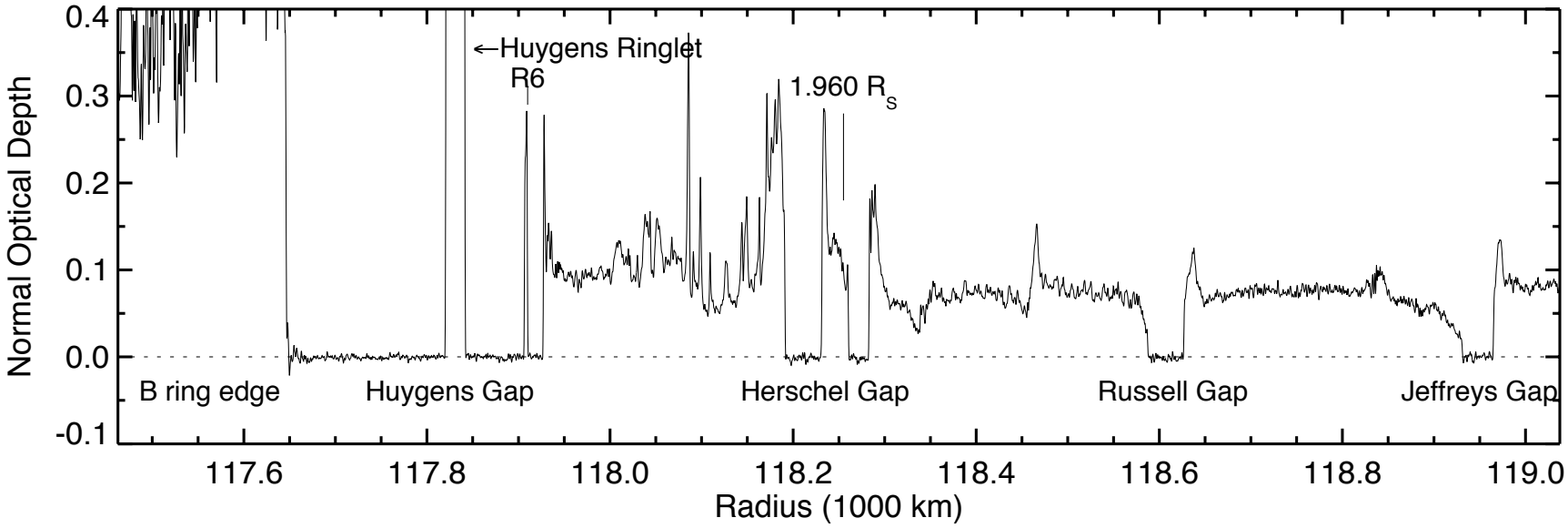
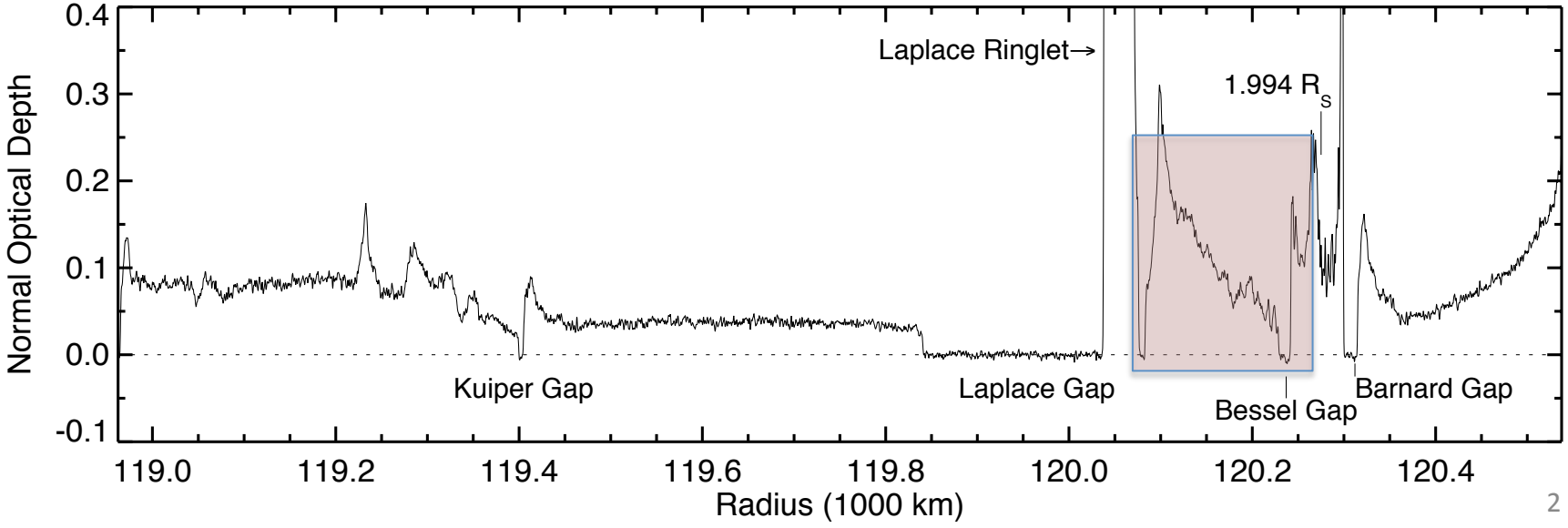
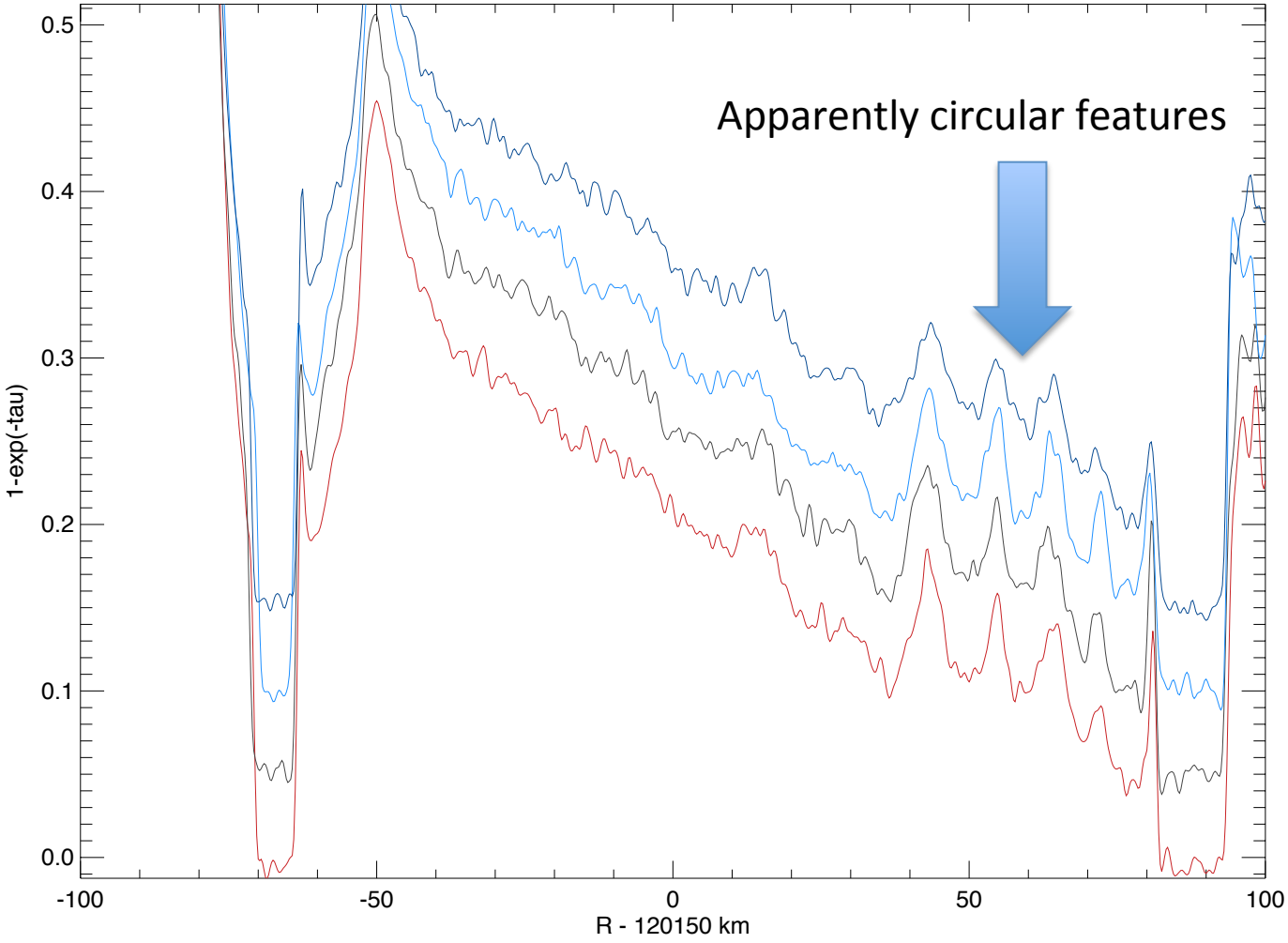
Cassini Division





Four RSS Occultation Profiles



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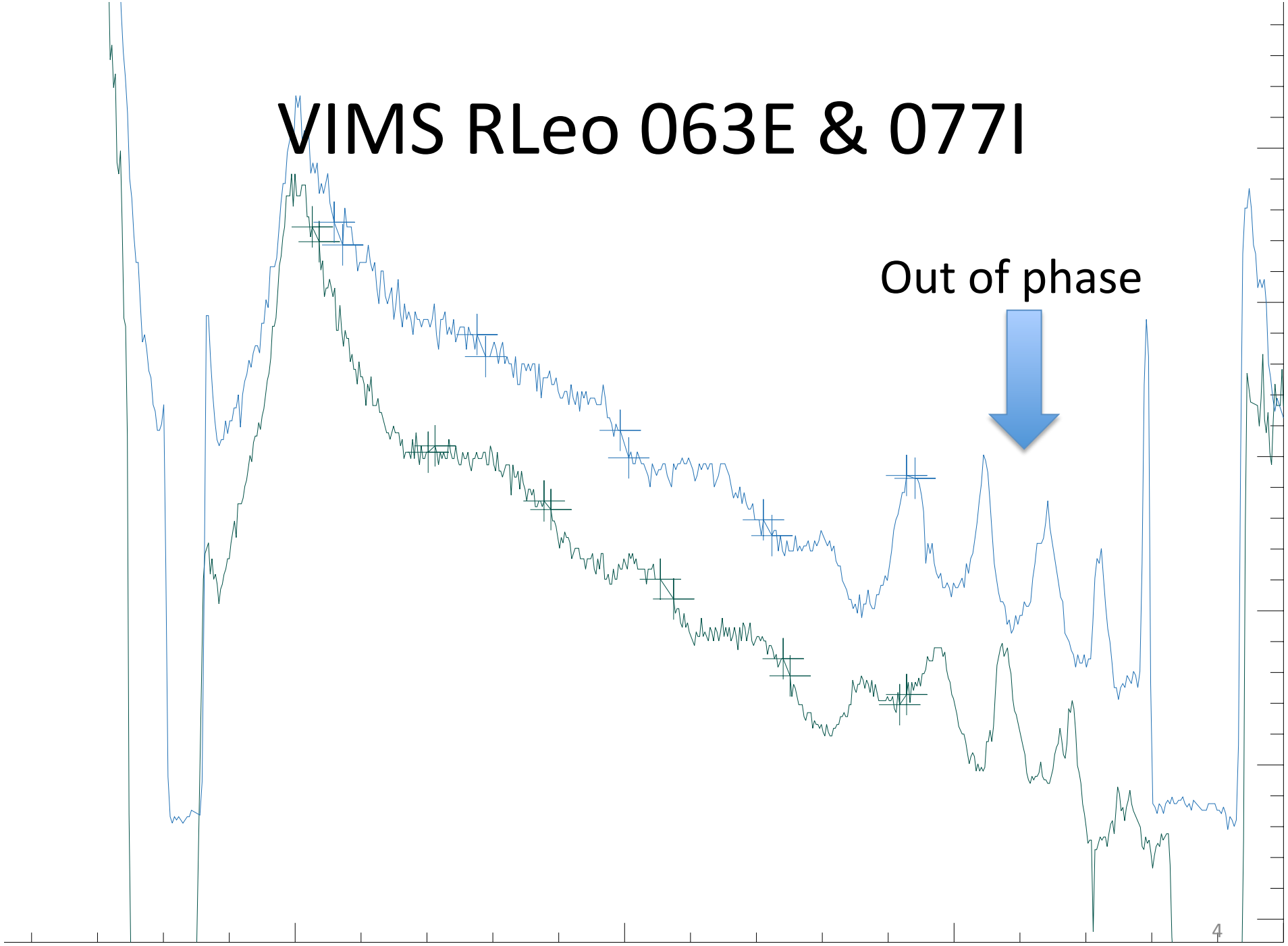
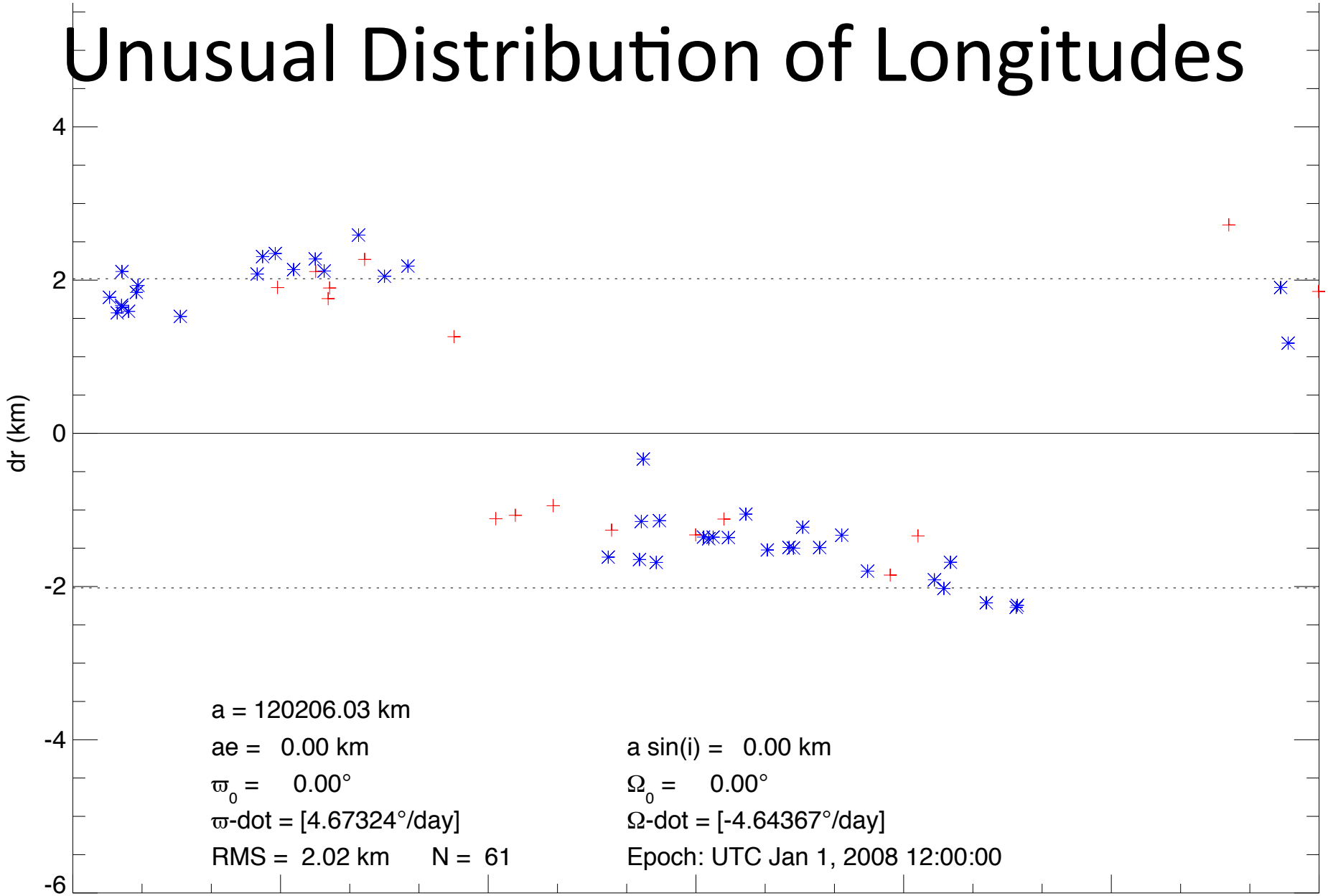
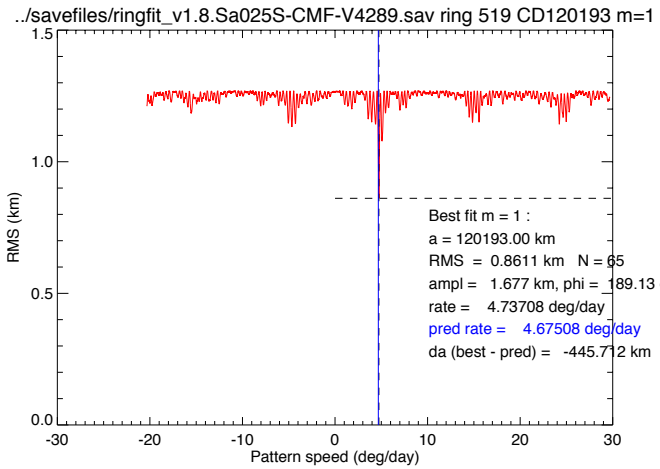
VIMS RLeo 063E & 077I

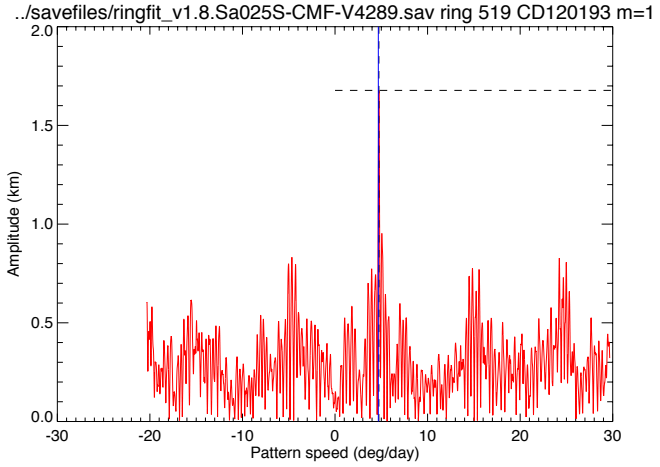


Unusual Distribution of Longitudes



Normal mode scans give same pattern speed for adjacent features





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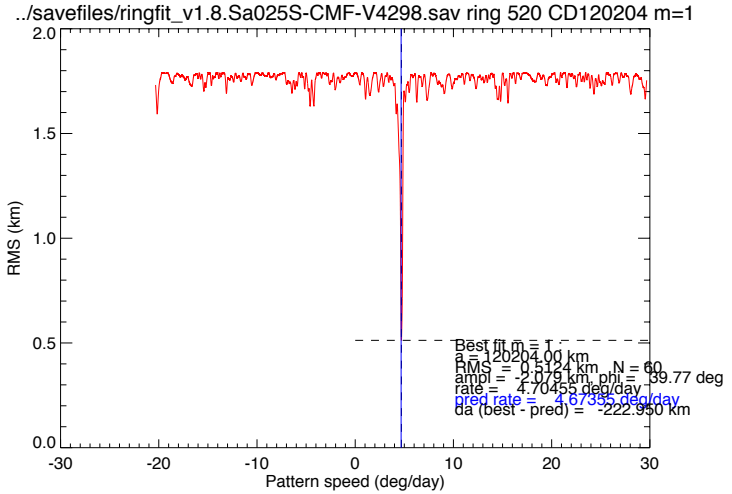

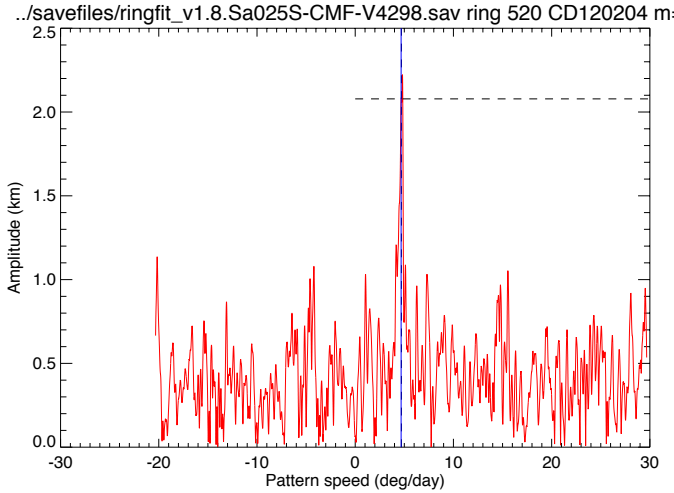

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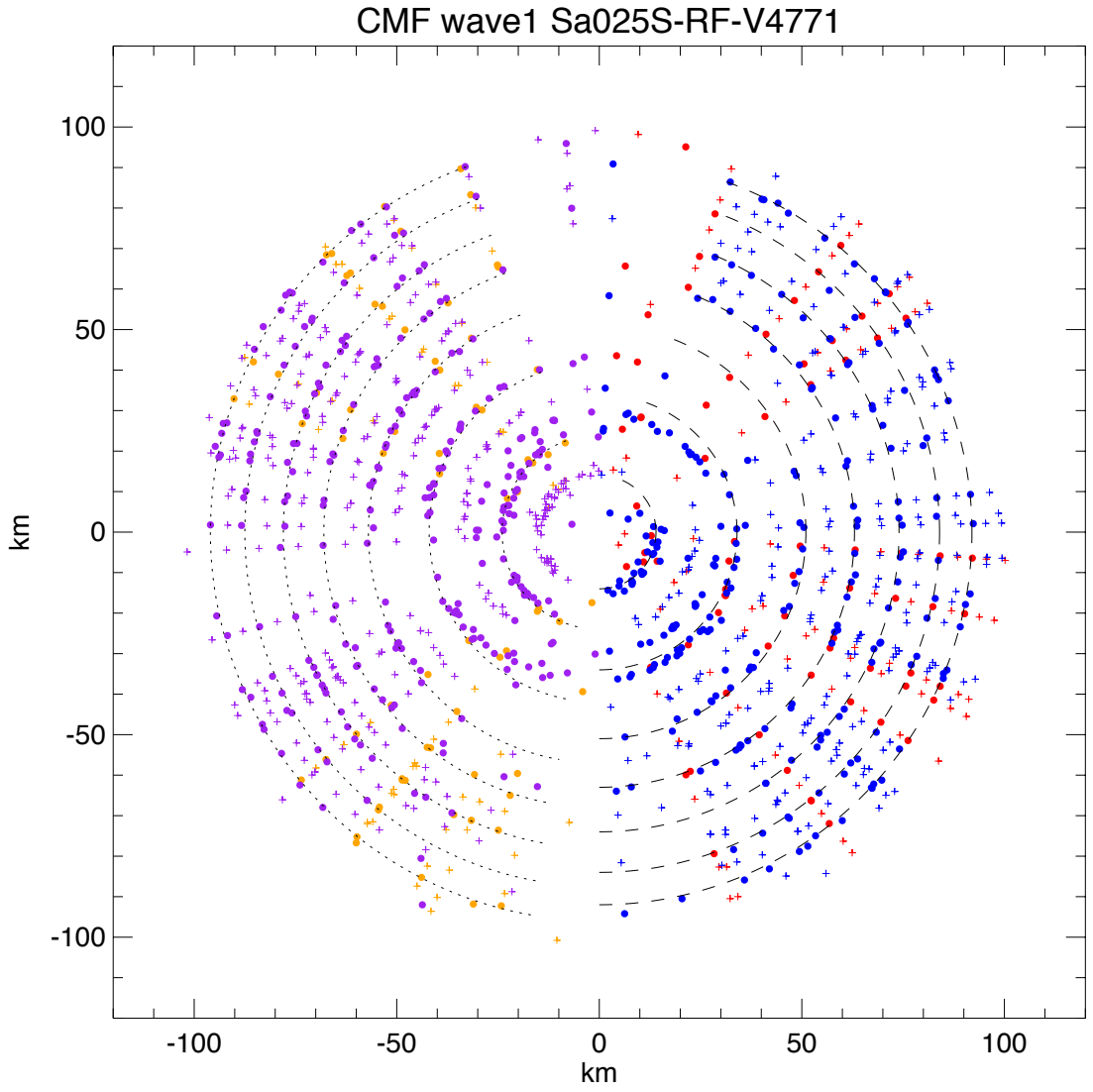
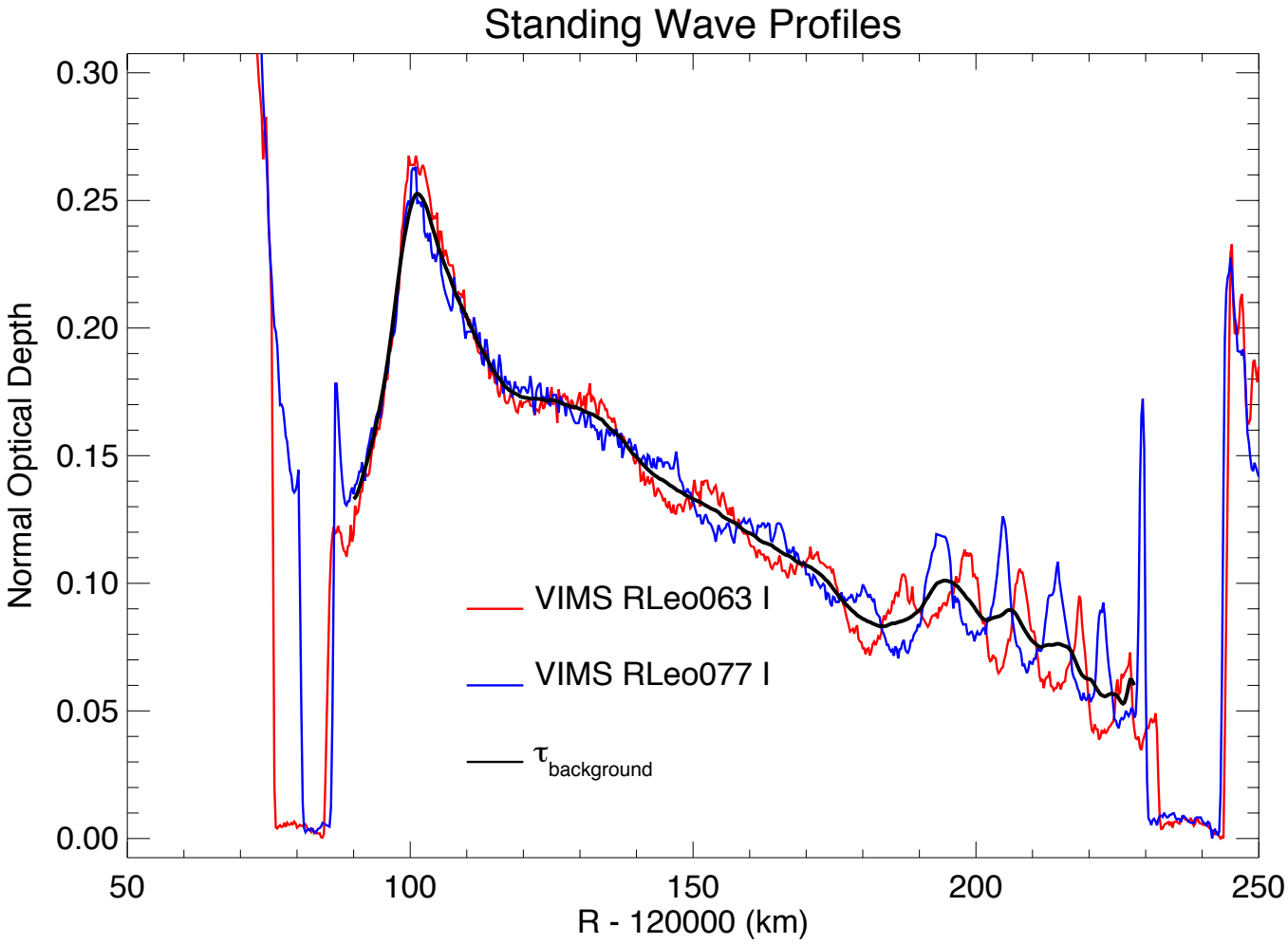
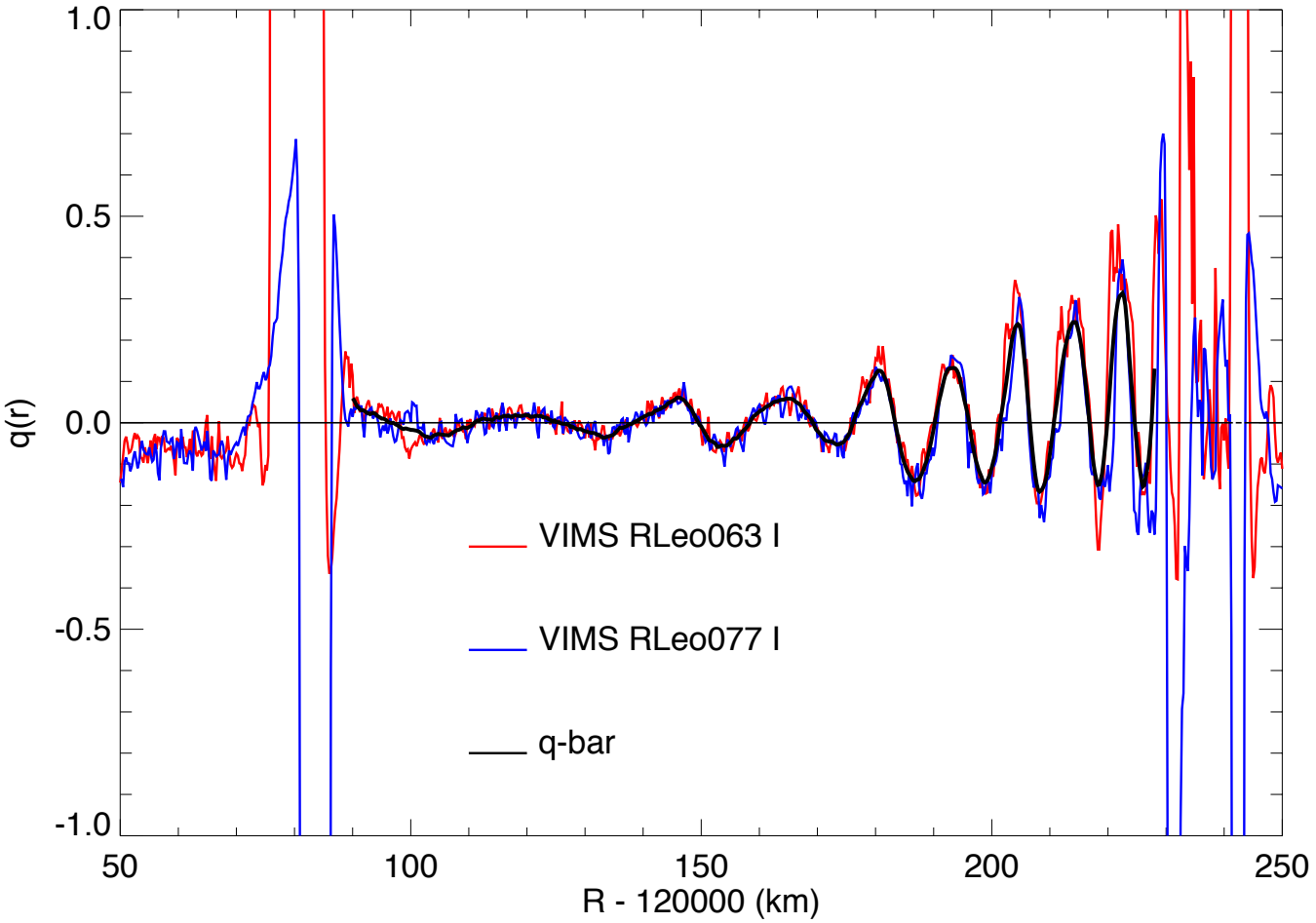
Zones of Avoidance



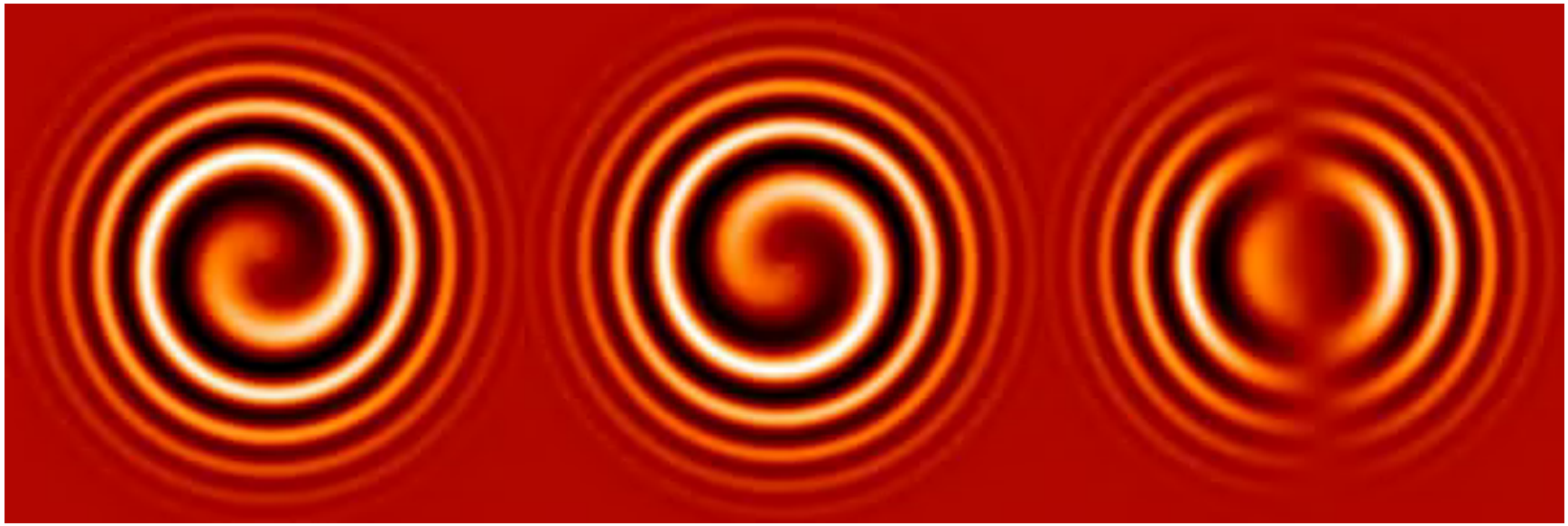
Best anti-aligned wave profiles



Eccentricity Gradient q(r)

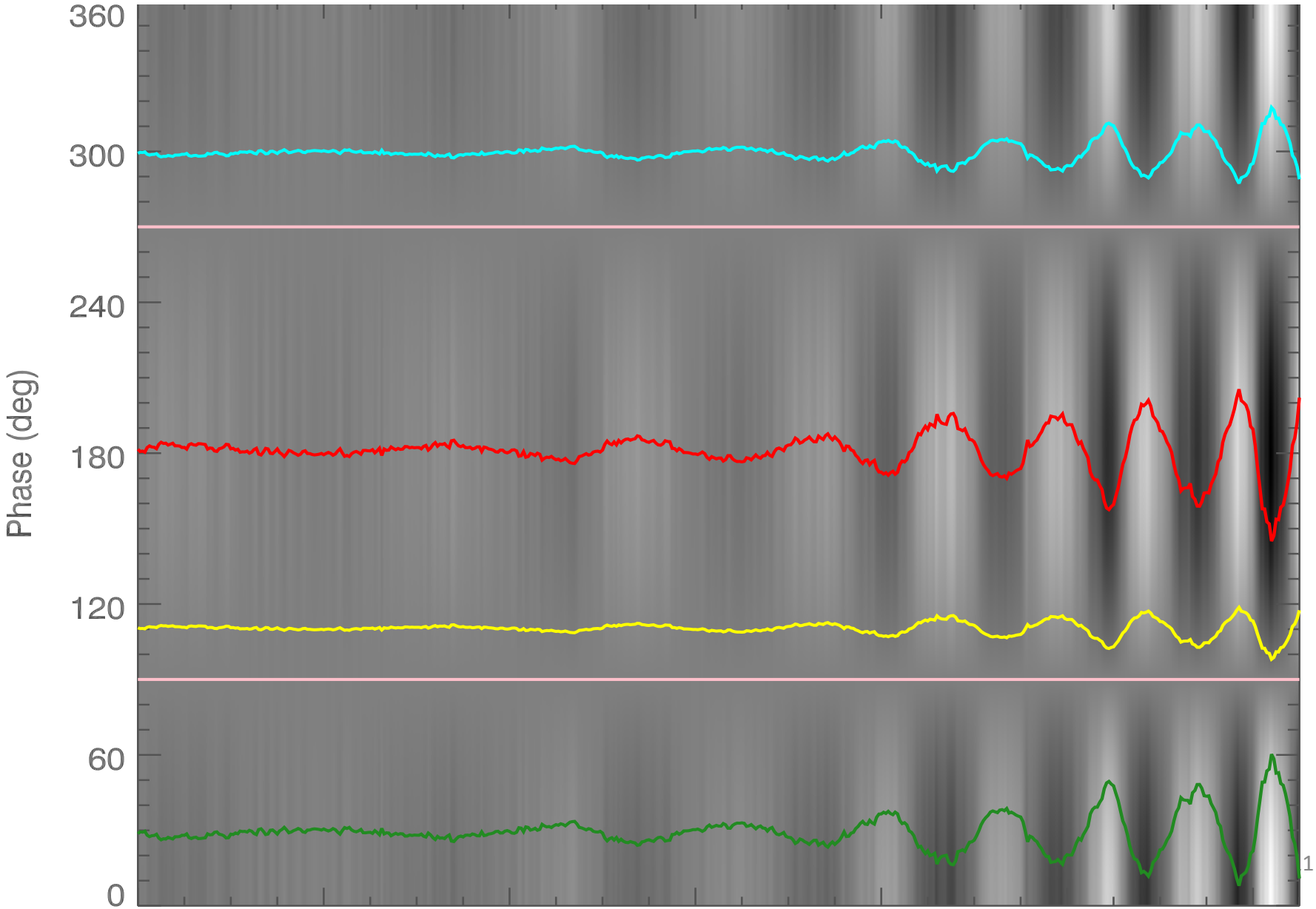


Generation of Standing Wave: Coaddition of leading/trailing prograde density waves

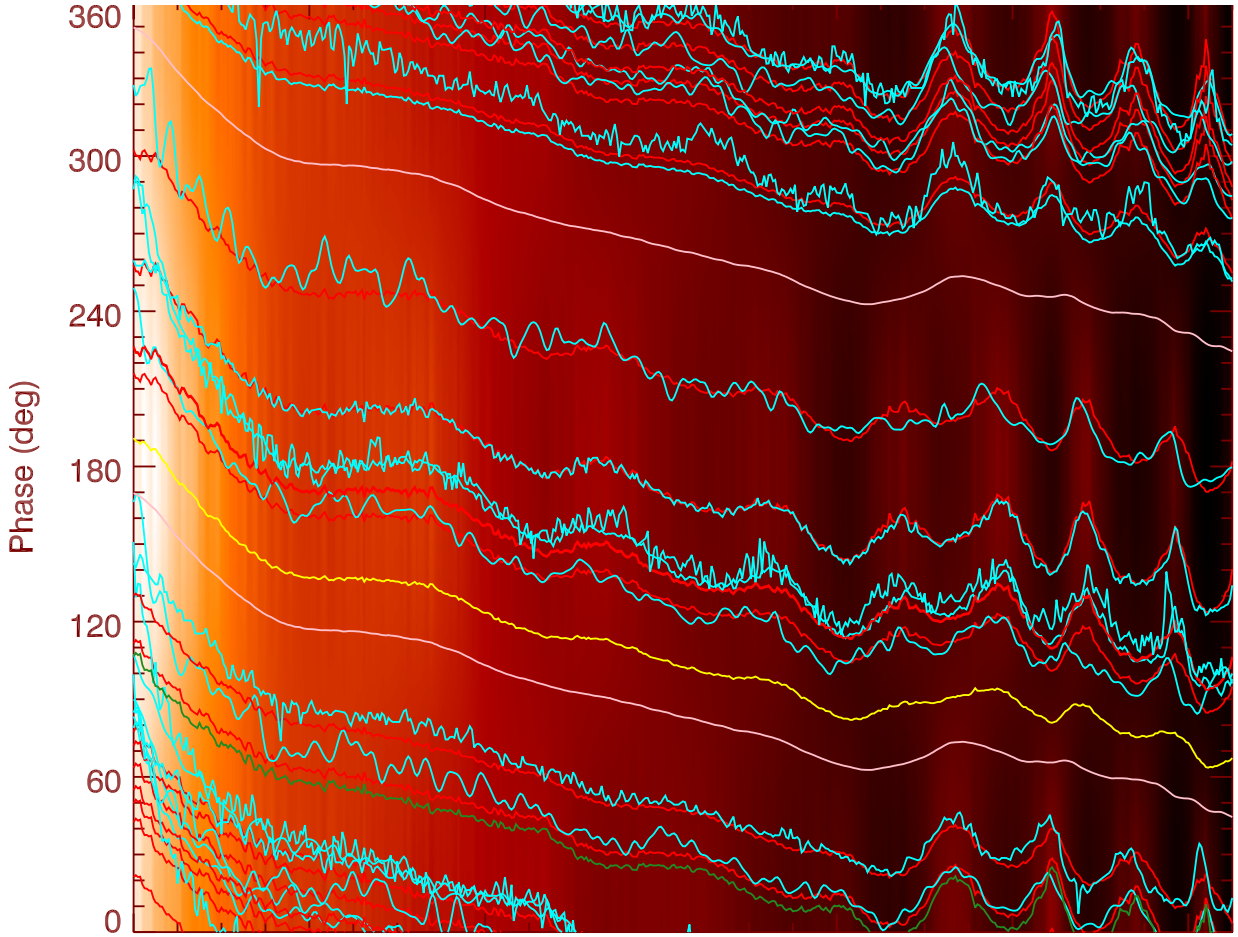


Leading Trailing Standing

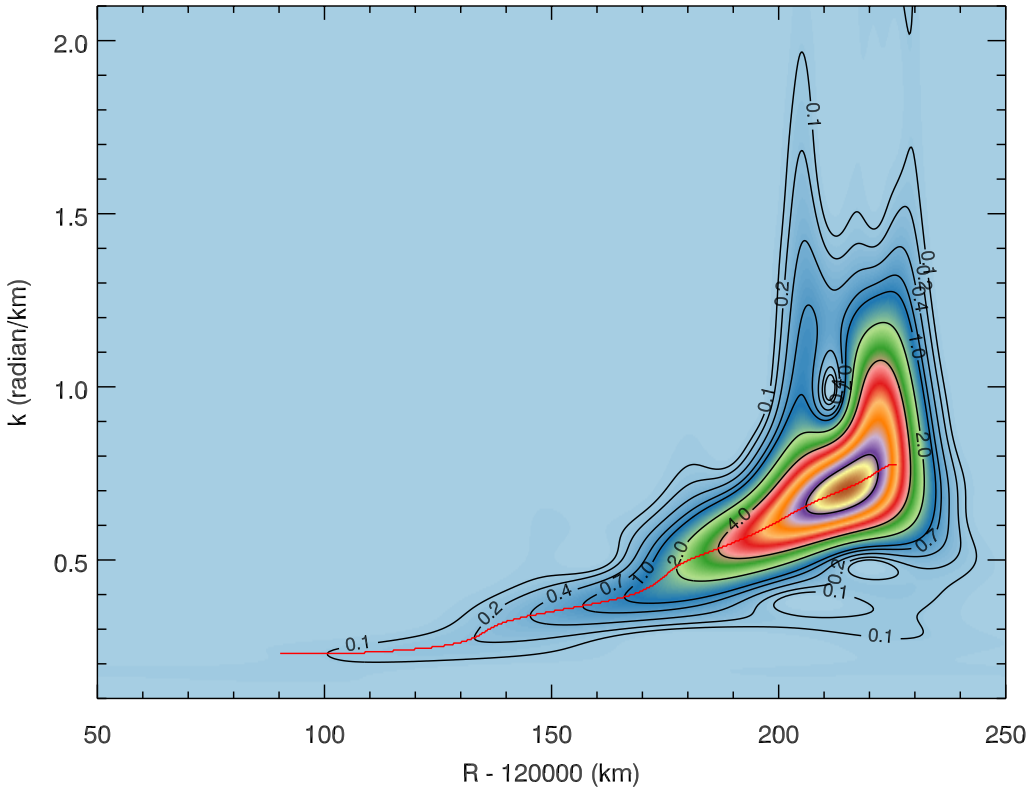
Two-dimensional q(r)

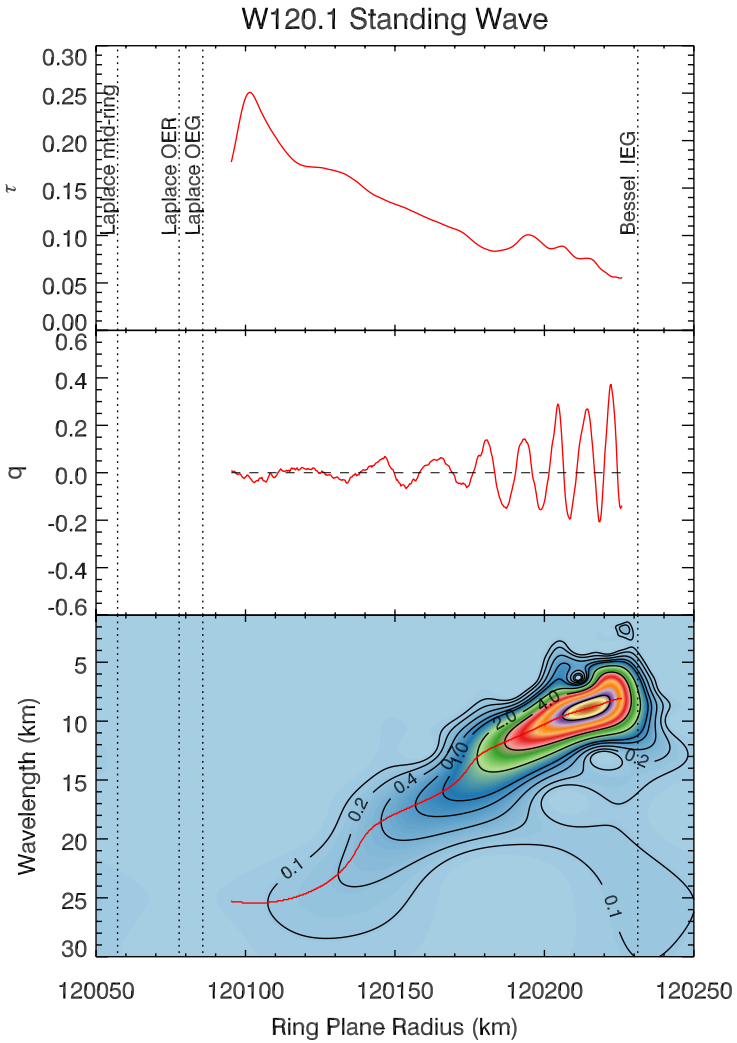


Observed optical depth profiles

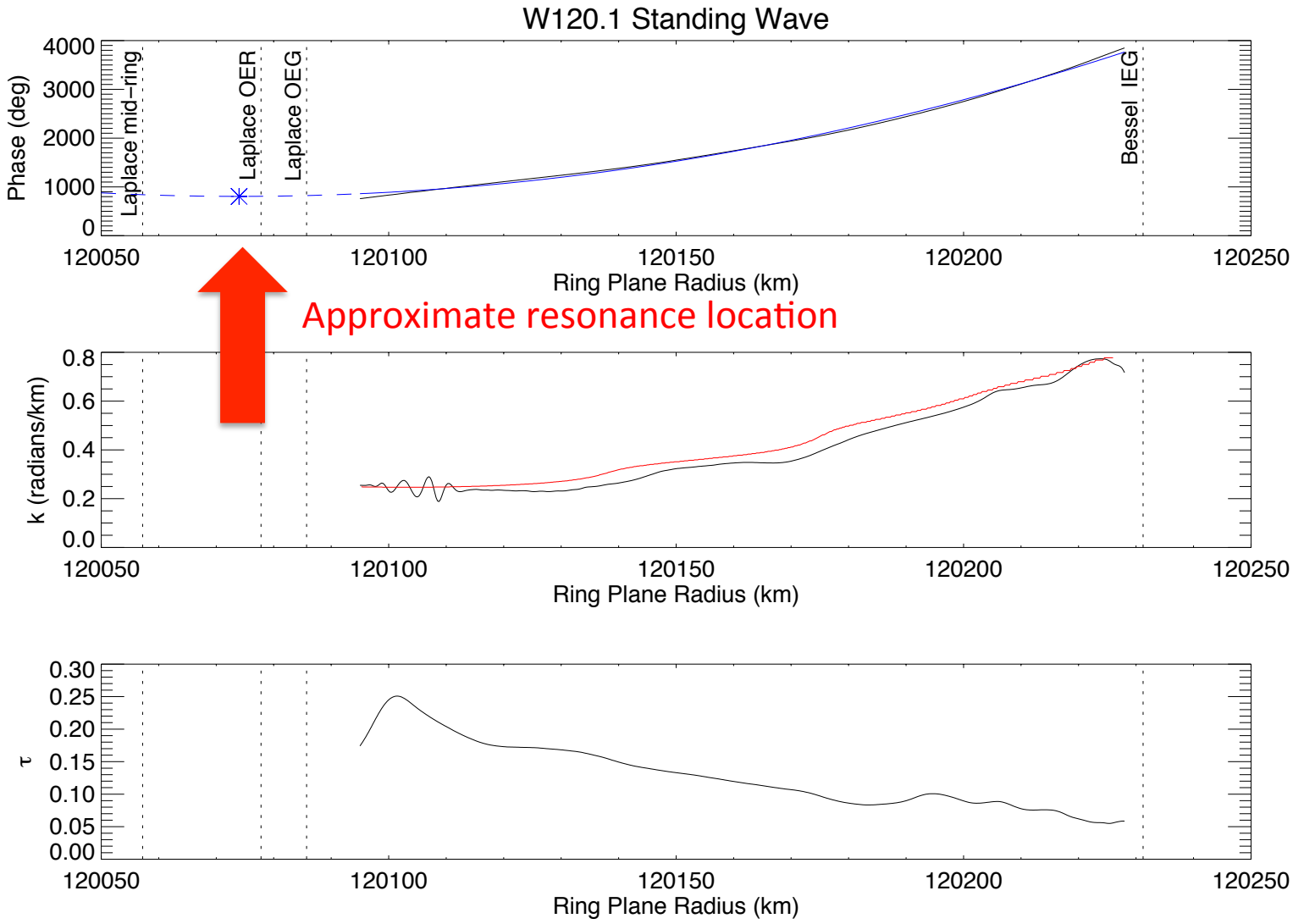


Wavelet decomposition

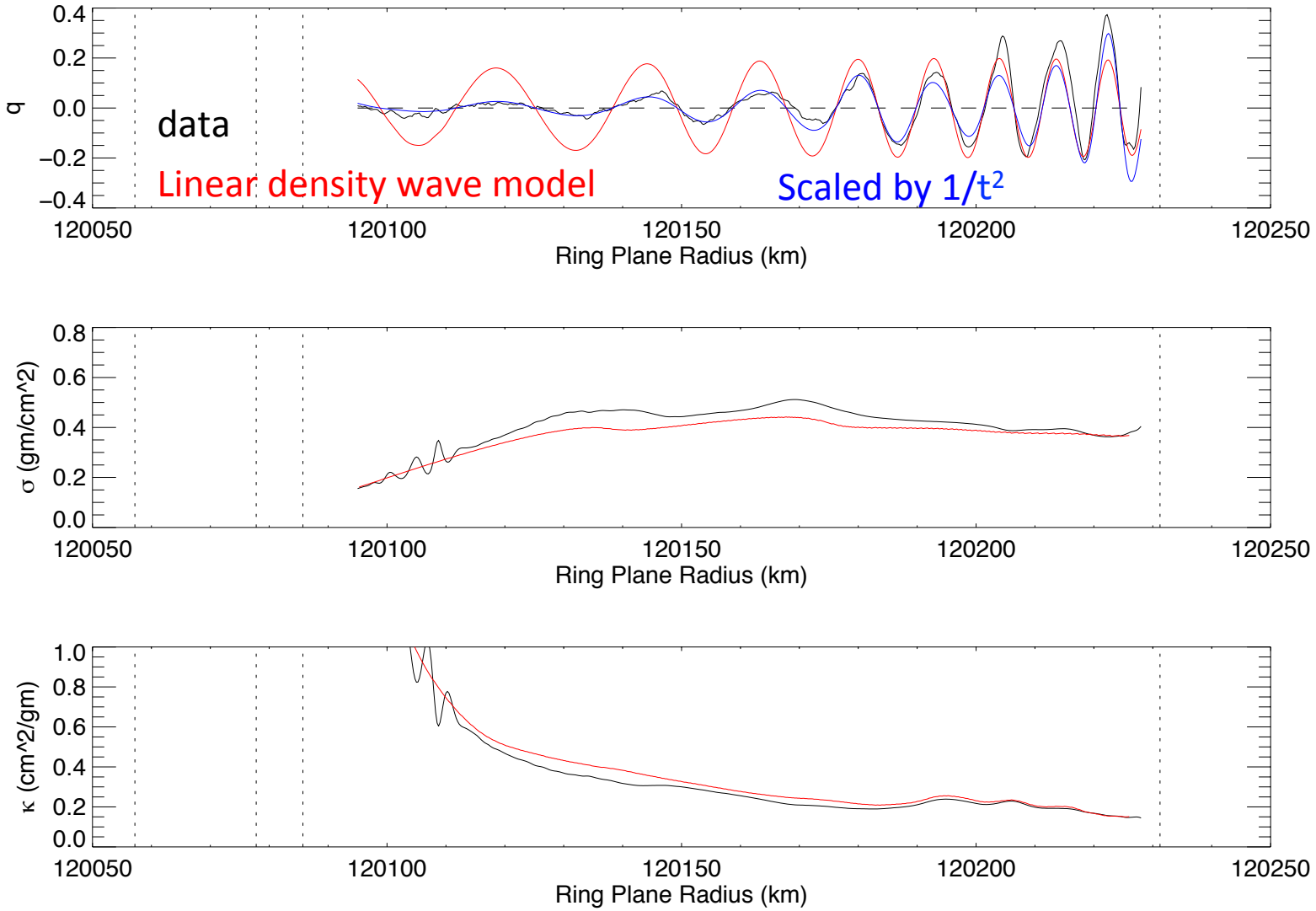




Estimating the resonance location



Matching q(r) and estimating s(r), k(r)



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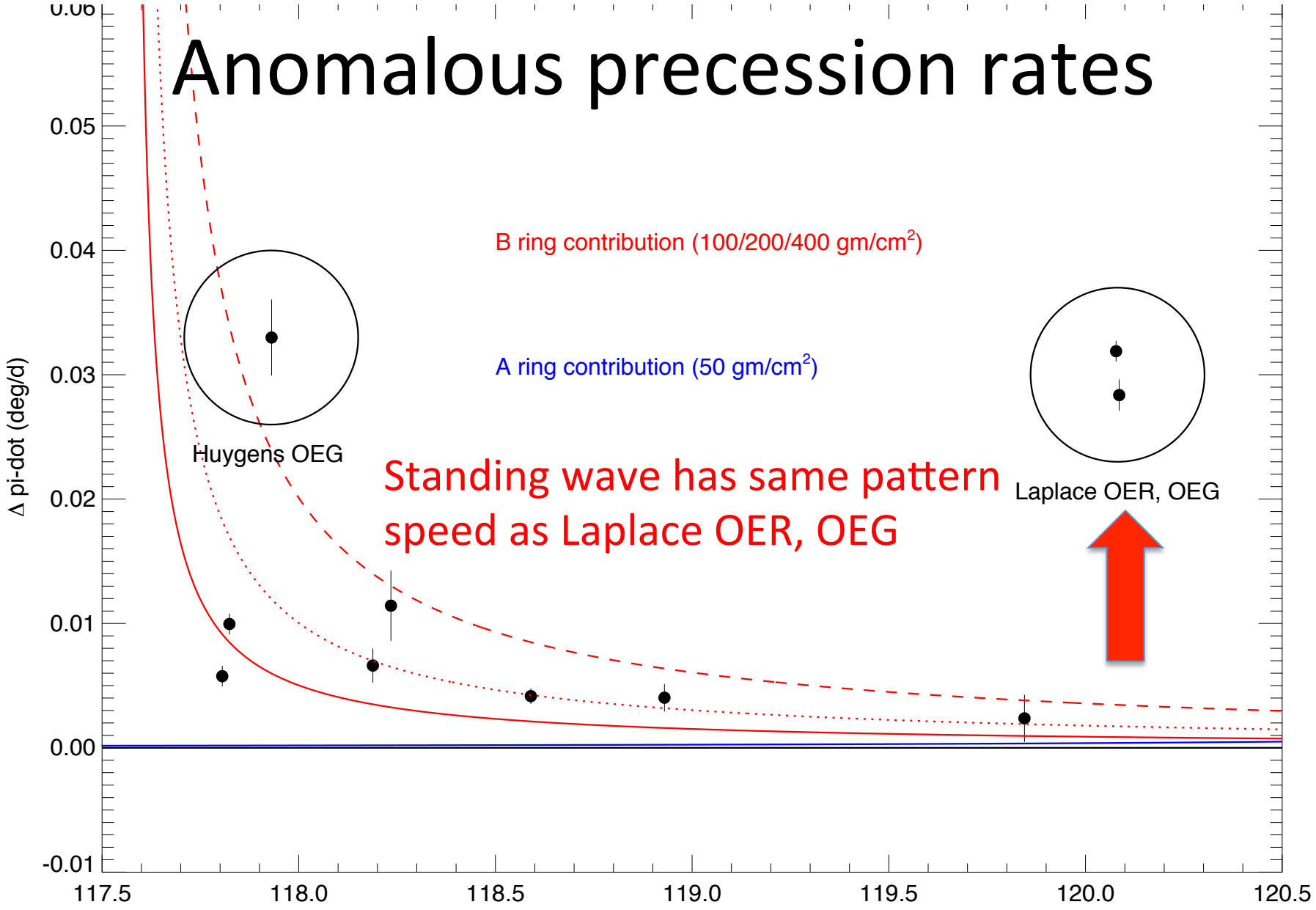
Anomalous precession rates



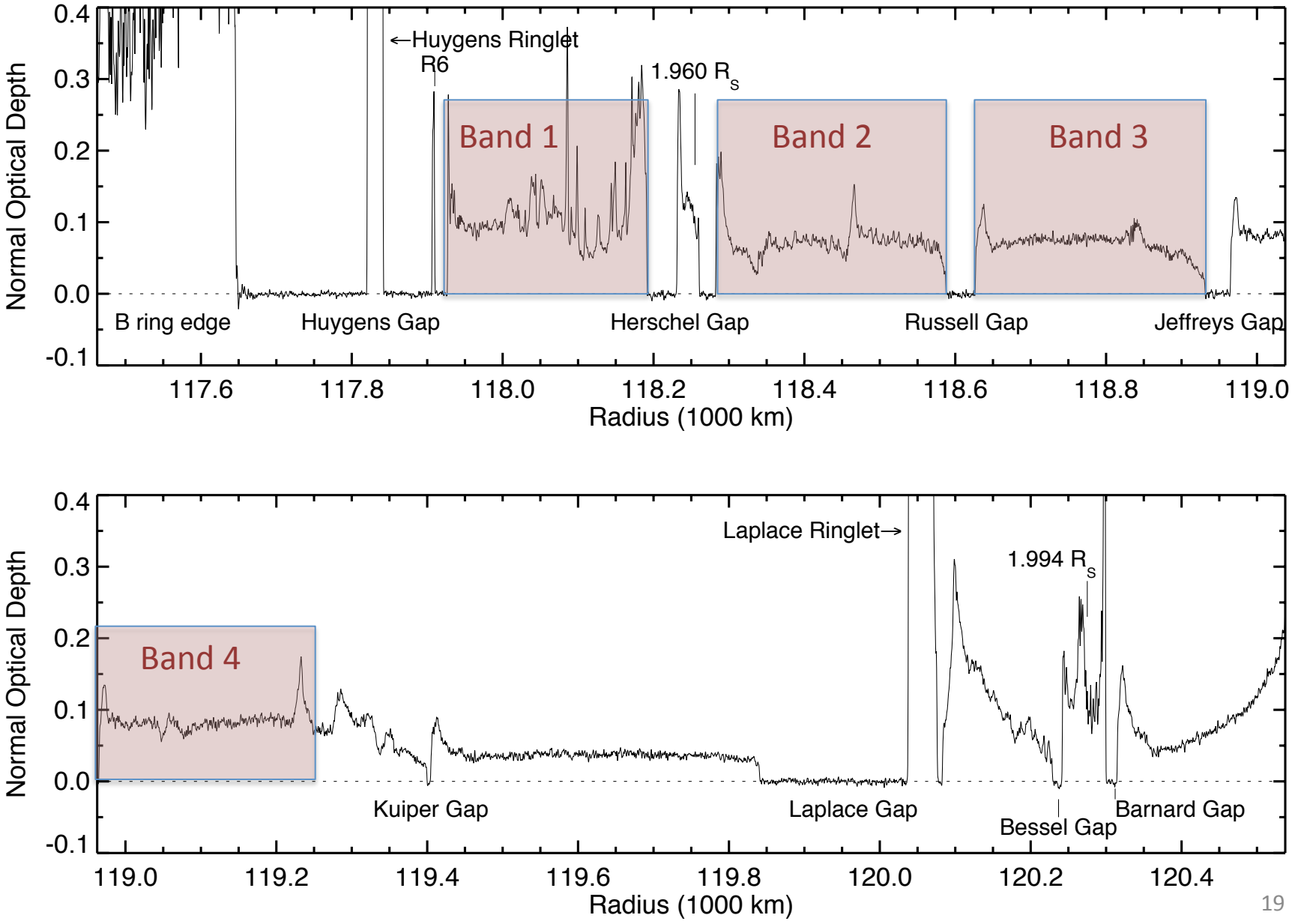
Summary of Wave Properties

- m=1 standing wave between Laplace OEG & Bessel IEG
- Laplace OEG:
  - a=120085.72 km, ae=1.36 km, W_P= 4.71875 deg/day (-203 km)
  - f= 310 deg at epoch (J2008)
  - m=2 (Mimas), Da=0.22 km, W_P= 381.986 deg/day
- Bessel IEG:
  - a=120231.23 km, ae=1.71 km, W_P= 4.68441 deg/day (-103 km)
  - m=2 (Mimas), Da=0.27 km, W_P= 381.979 deg/day, f=264 deg
- Standing wave l = 5-20 km (~9 wave crests)
- W_P= 4.72 deg/day (natural rate for a=119875 km)
- Approx. resonance location: a= 120075 km
- f=220 degrees (J2008) (90 degrees out of phase)

Standing Wave - Open questions

- Dynamical explanation of standing wave:
  - Driven by Laplace OEG at inner edge?
  - Why this pattern speed?
  - Outer edge – reflection – has different pattern speed
  - Phase difference of 90 deg – significance?
- Amplitude of wave vs. radius – "shallow water"?
- Phase of linear density wave model?
- Detection in Cassini ISS images? (<5 km/px)

Flynn & Cuzzi (1989) Bands in the Cassini Division



Flynn & Cuzzi (1989) results (FC89)

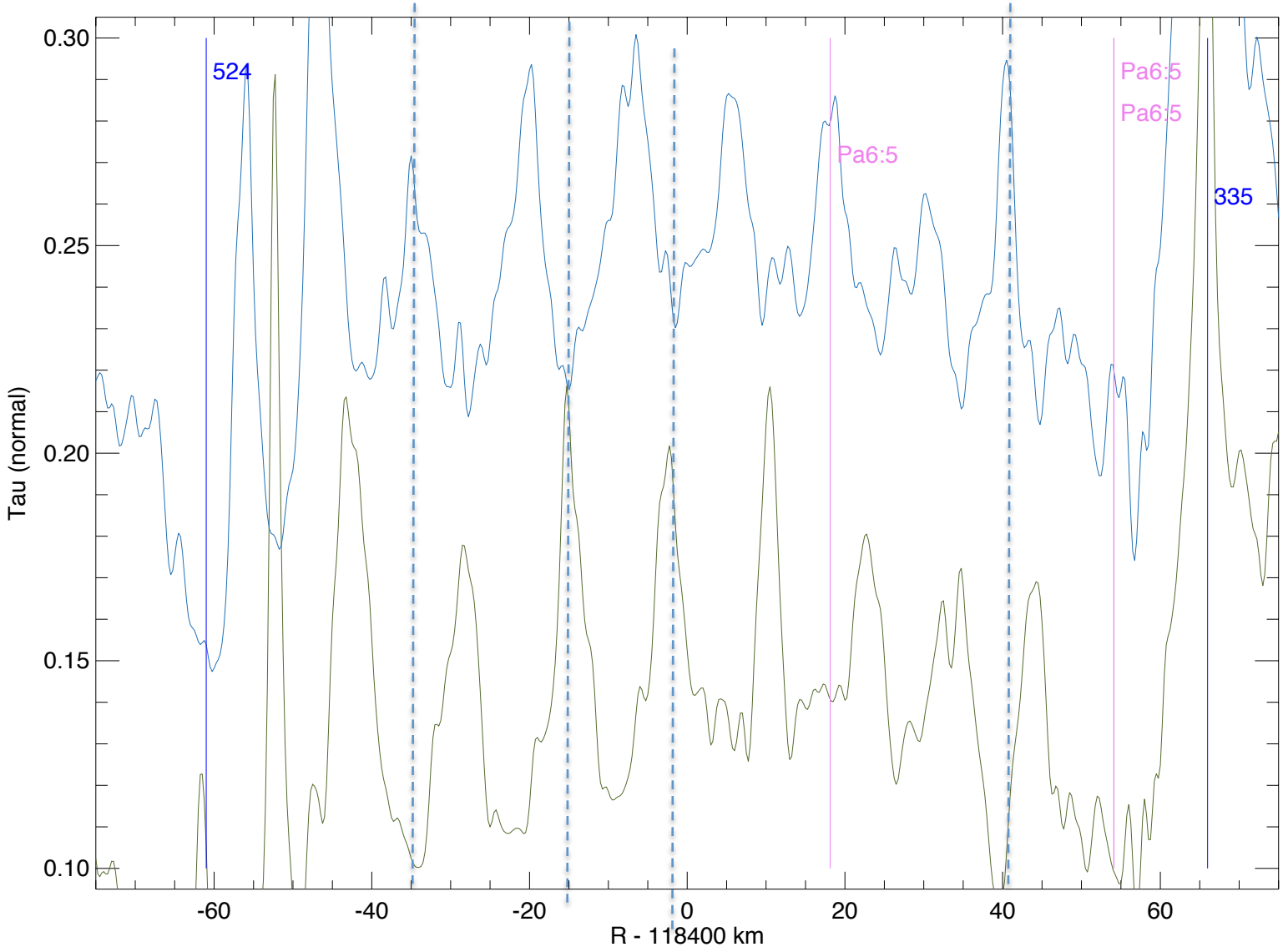
- Band 1 had been interpreted as due to wakes of two 10-km radius moonlets (Marouf & Tyler 1986) from Voyager RSS results

- FC89 concluded that Band 1 is "essentially azimuthally symmetric" – but could also be m=1 ILR.

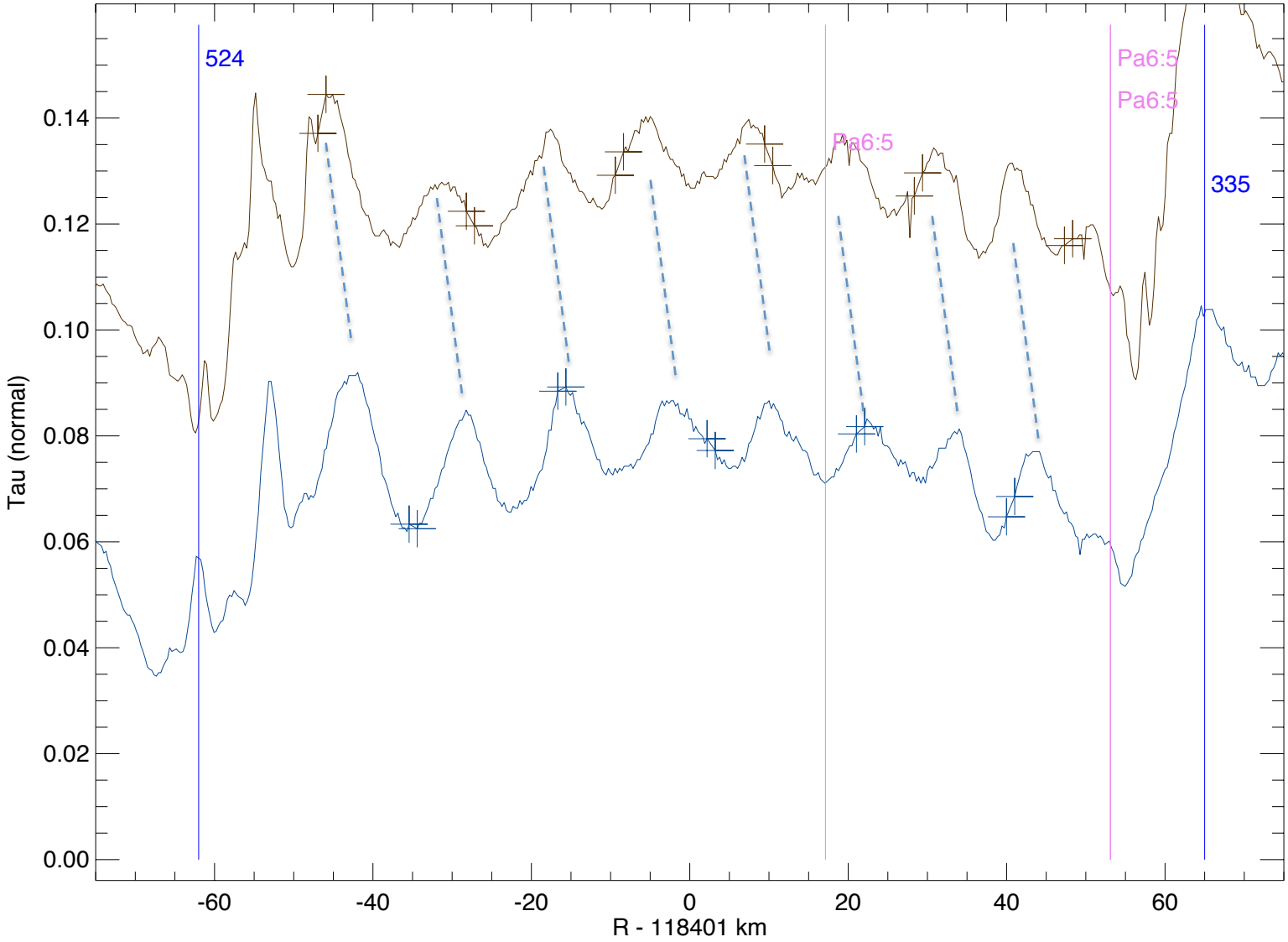
- No wave identification for Bands 2, 3, or 4

- With much more complete high-resolution Cassini occultation data, we can examine this structure in much greater detail than possible from Voyager data alone – FC89 used 6 Vgr images, Vgr 1 RSS and Vgr 2 PPS occ.

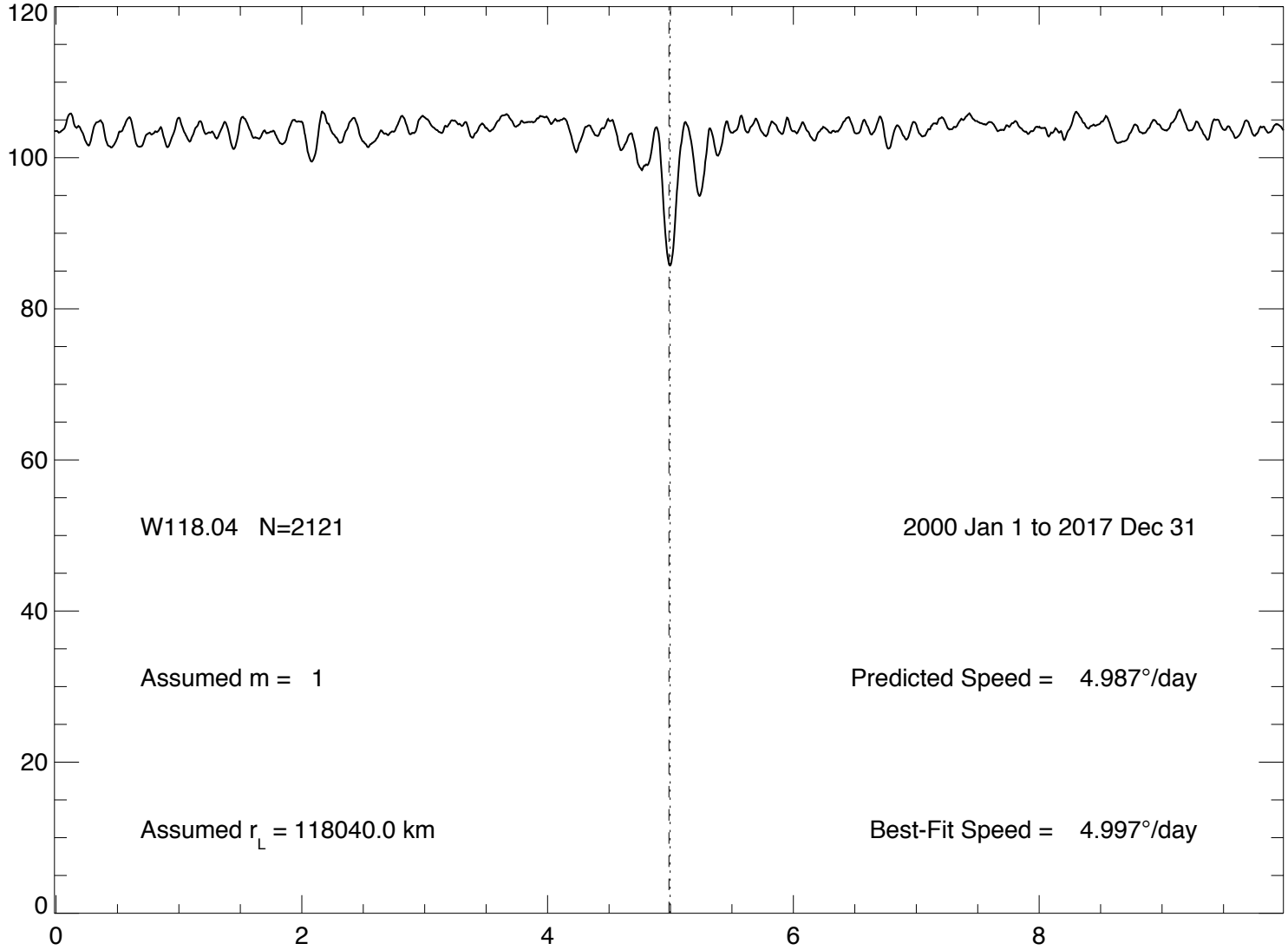
Band 1 – Cassini RSS 054I/056I
Prominent waves, anti-correlated



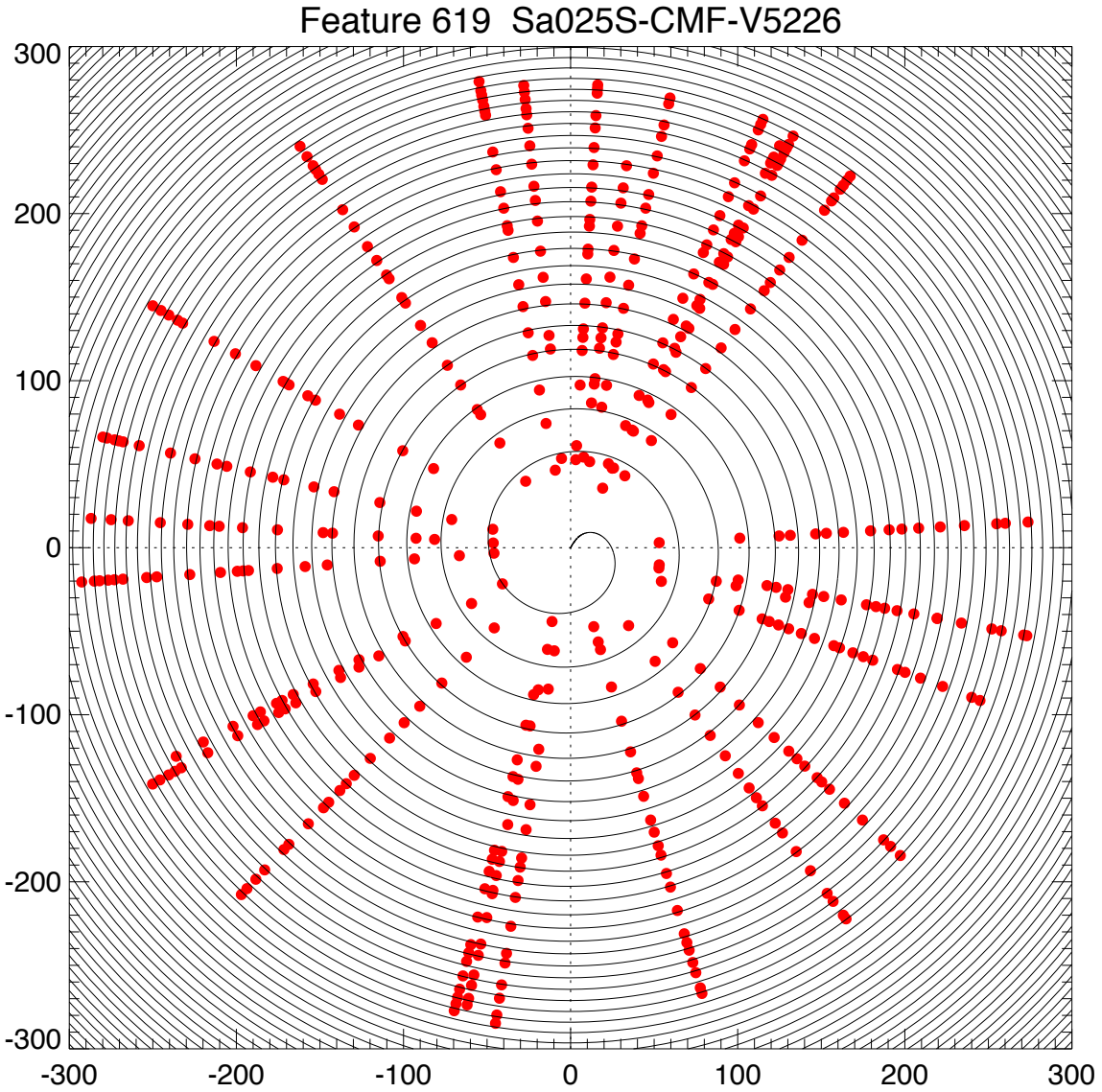
VIMS omiCet 008I/008E
NOT anti-correlated but phase-shifted

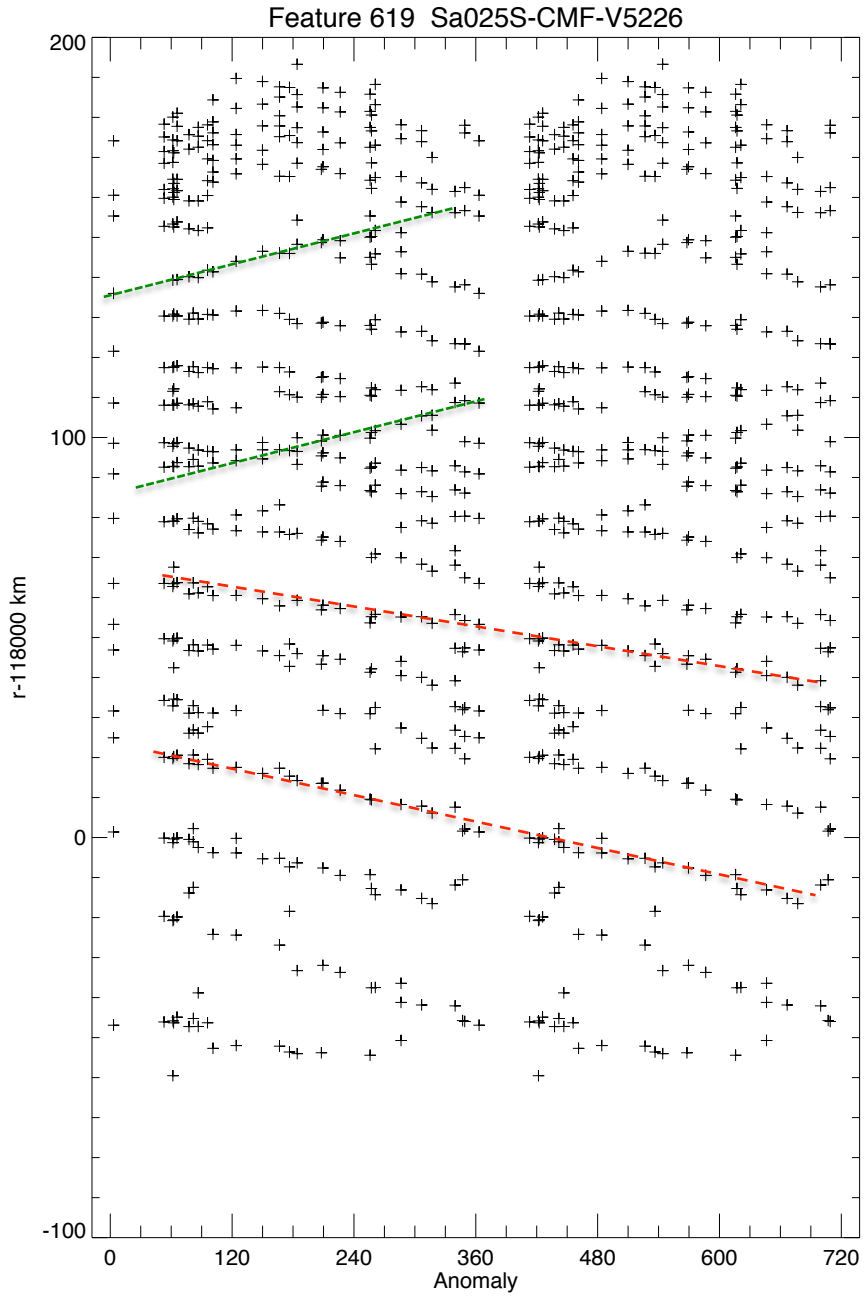


Band 1: W118.04 m=1 ILR



FC Band 1 – wave crests and m=1 wave

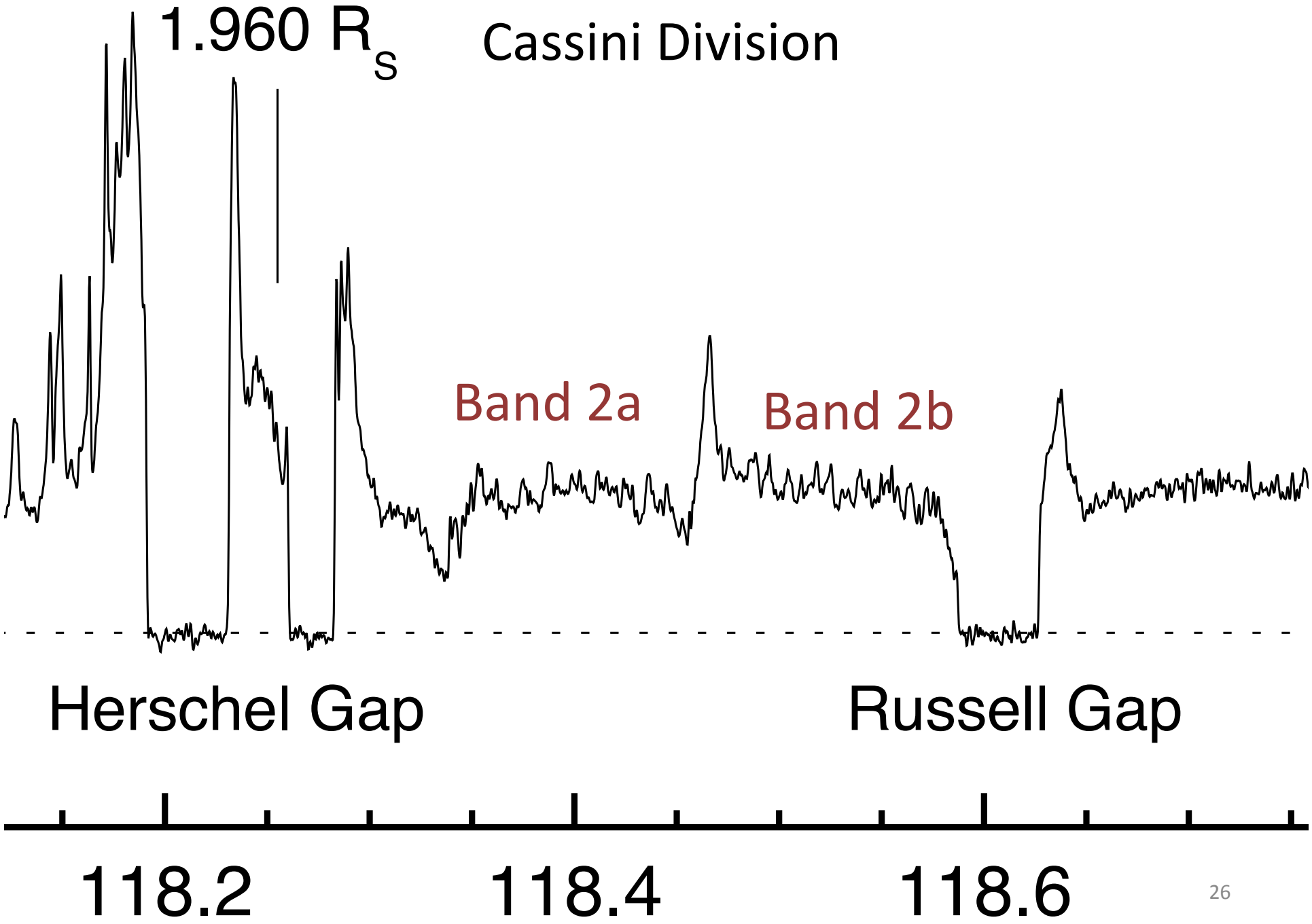




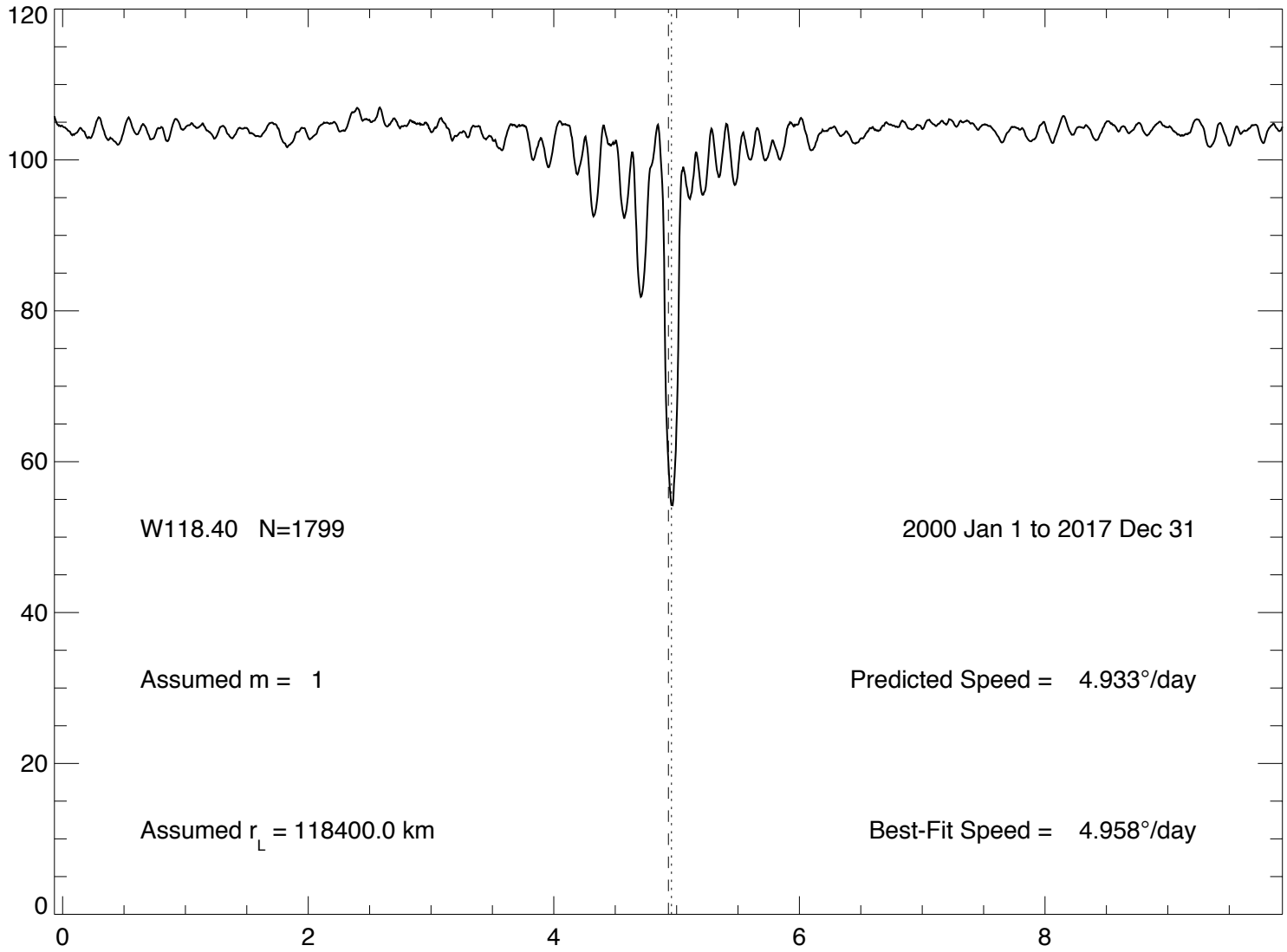
Evidence of wave reflection:

trailing wave- r decreases with anomaly, f

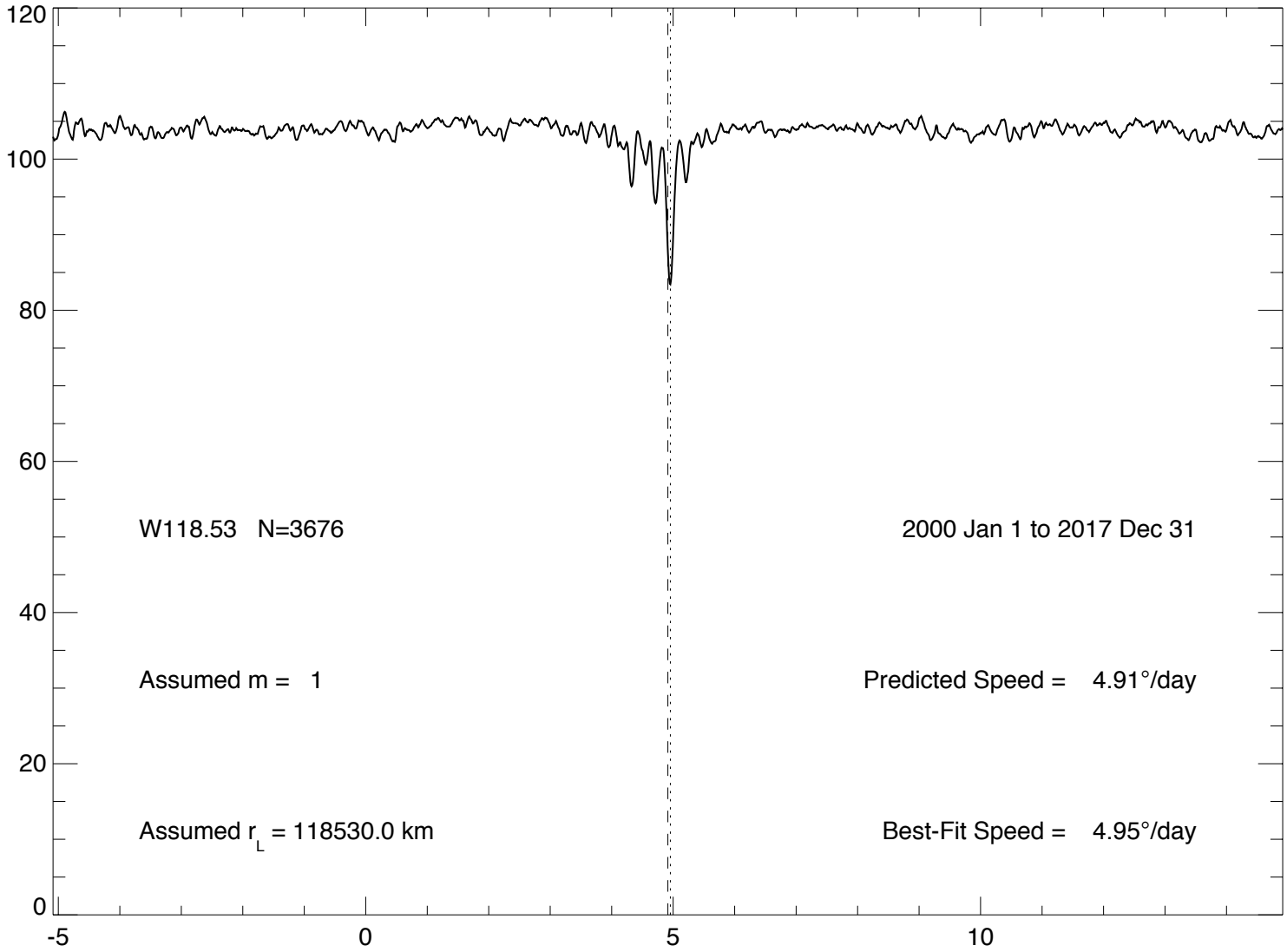
reflected wave: r increases with f


1.960 R_S
Cassini Division
Band 2a
Band 2b
Herschel Gap
Russell Gap
118.2
118.4
118.6

Band 2a: W118.40 m=1 ILR



Band 2b: W118.53 m=1 ILR



Conclusions: F&C Bands:

- Band 1: W118.04 m=1 ILR, W_p= 5.00 deg/day
- Evidence of wave reflection at gap edge
- Band 2: Both a & b are same m=1 ILR
  - W118.40, W118.53 W_p= 4.95 deg/day
- No waves identified in Bands 3 or 4
- No nearby ringlets have these pattern speeds
- Not yet clear what drives these waves