

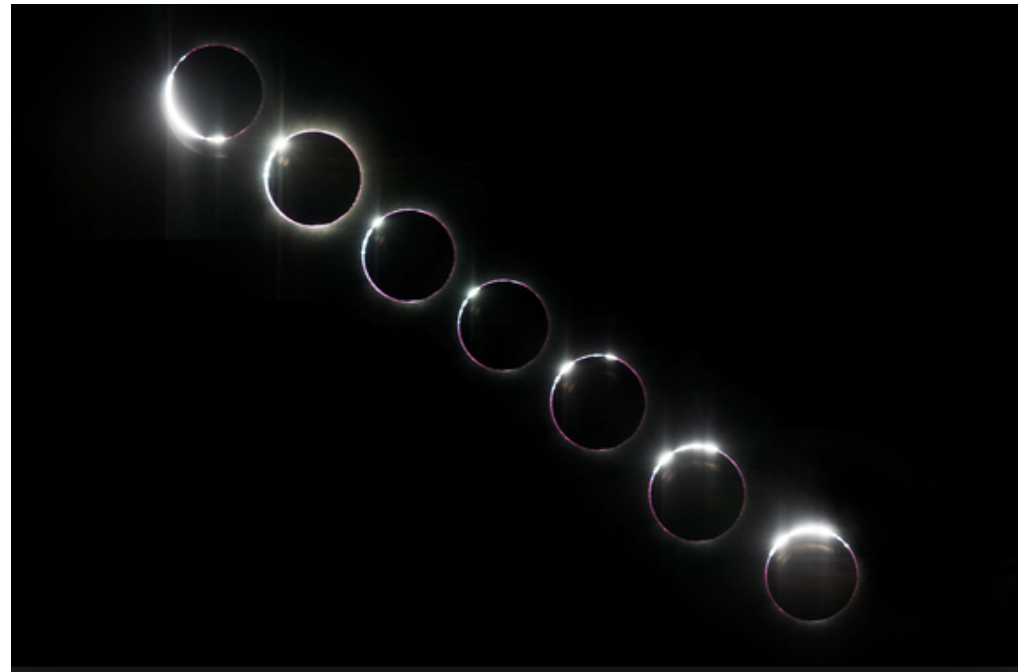
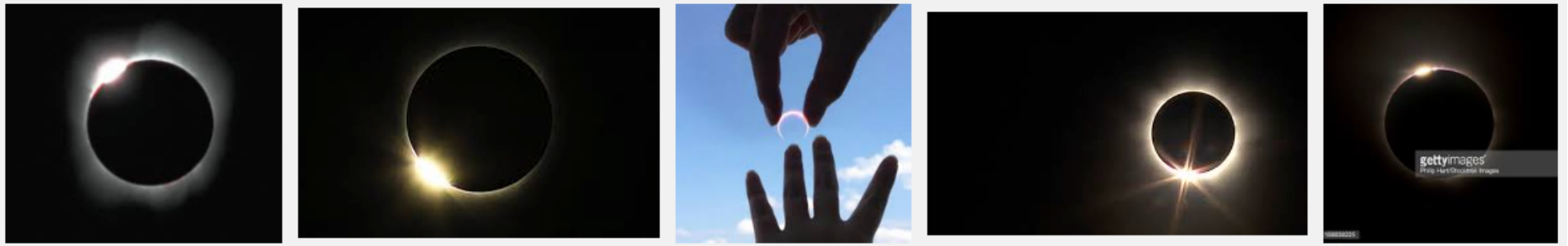
# Status of the Diamond Ring Movie

Hugh Hudson  
SSL, UC Berkeley and U. Of Glasgow

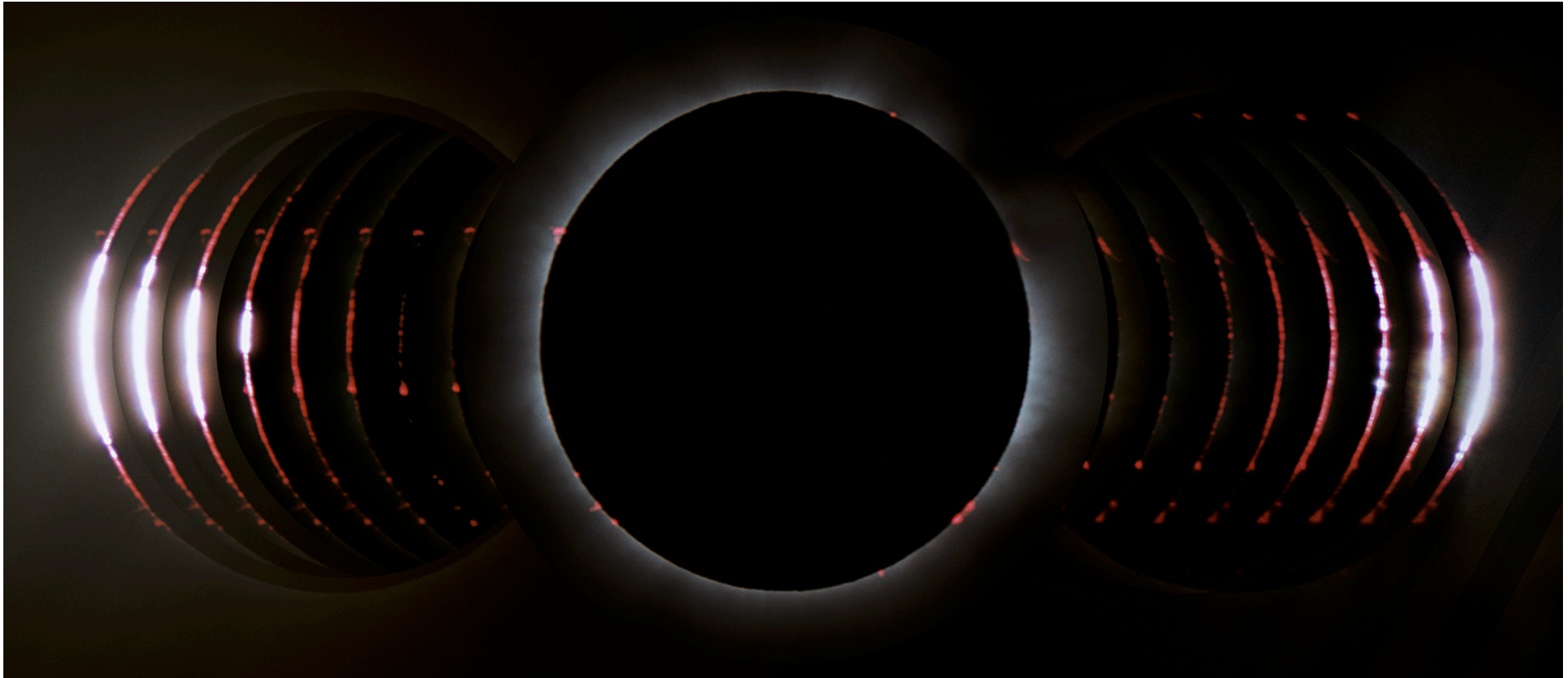
# What's the Diamond Ring movie?

- This is the “teramovie,” the native smartphone cameras, from the 2<sup>nd</sup> and 3<sup>rd</sup> contacts
- There is strong science content here
- I think there is excellent scope for visualization and participation

# The eclipse “Diamond ring”



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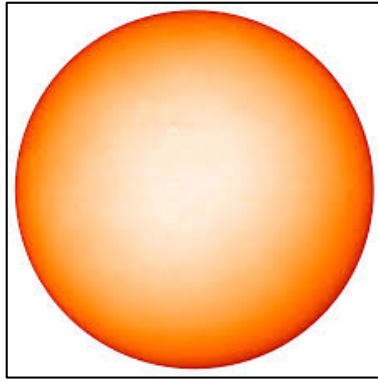
Courtesy Glenn Schneider

Notes: There's a chromosphere, a nuisance here  
A large arc, not just a final point, will appear

# Diamond Ring science

- The last glimpse of the photosphere, from metadata, locates the limb of the Sun very precisely
- The extensive time series from 2017 lets us study the *proper motion* of the limb
- The rate of change of photospheric signal determines the limb darkening\*
- The movie will check the selenography

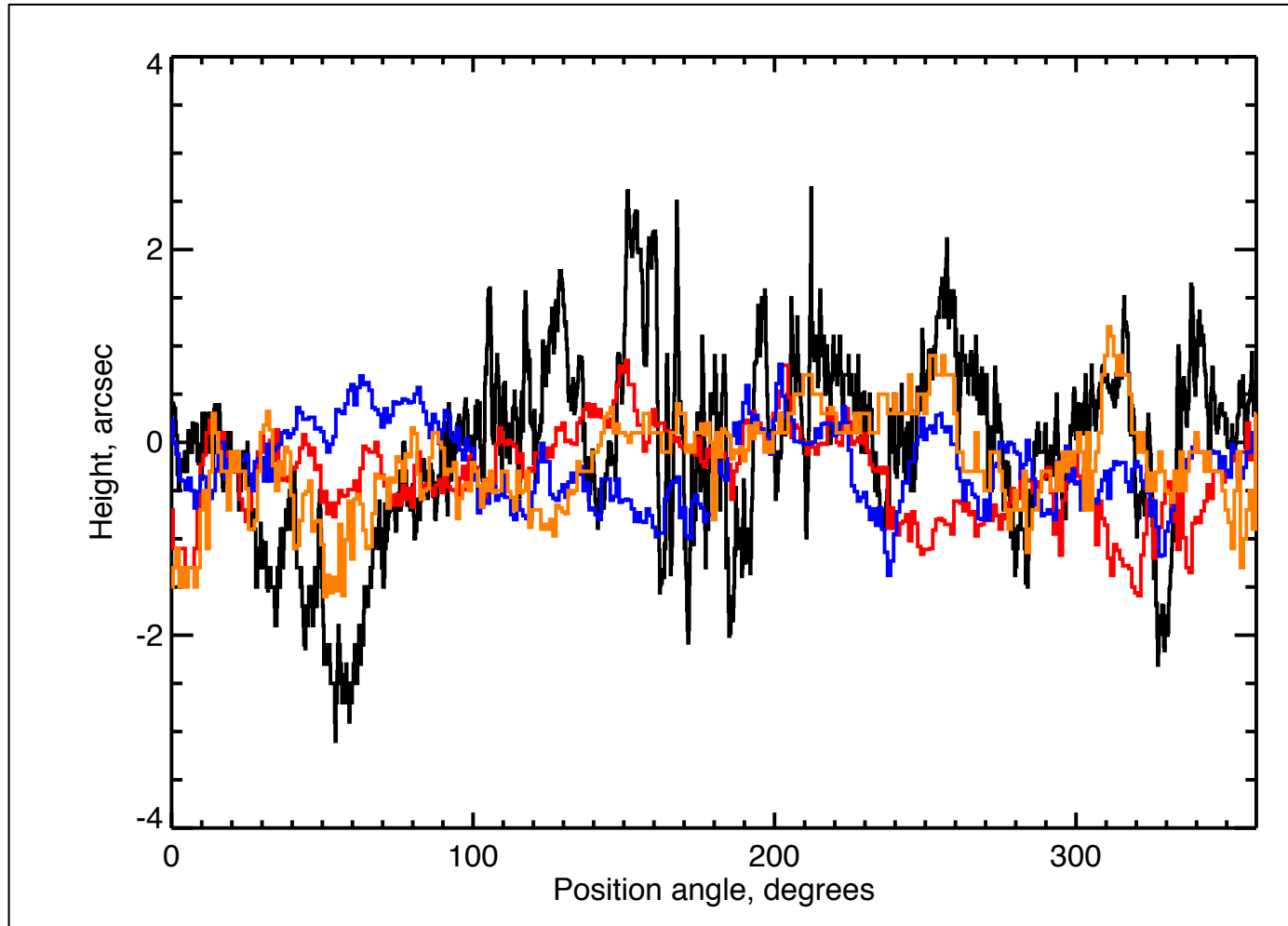
# What is “limb darkening”?



The solar extreme limb is about 40% as bright as disk center

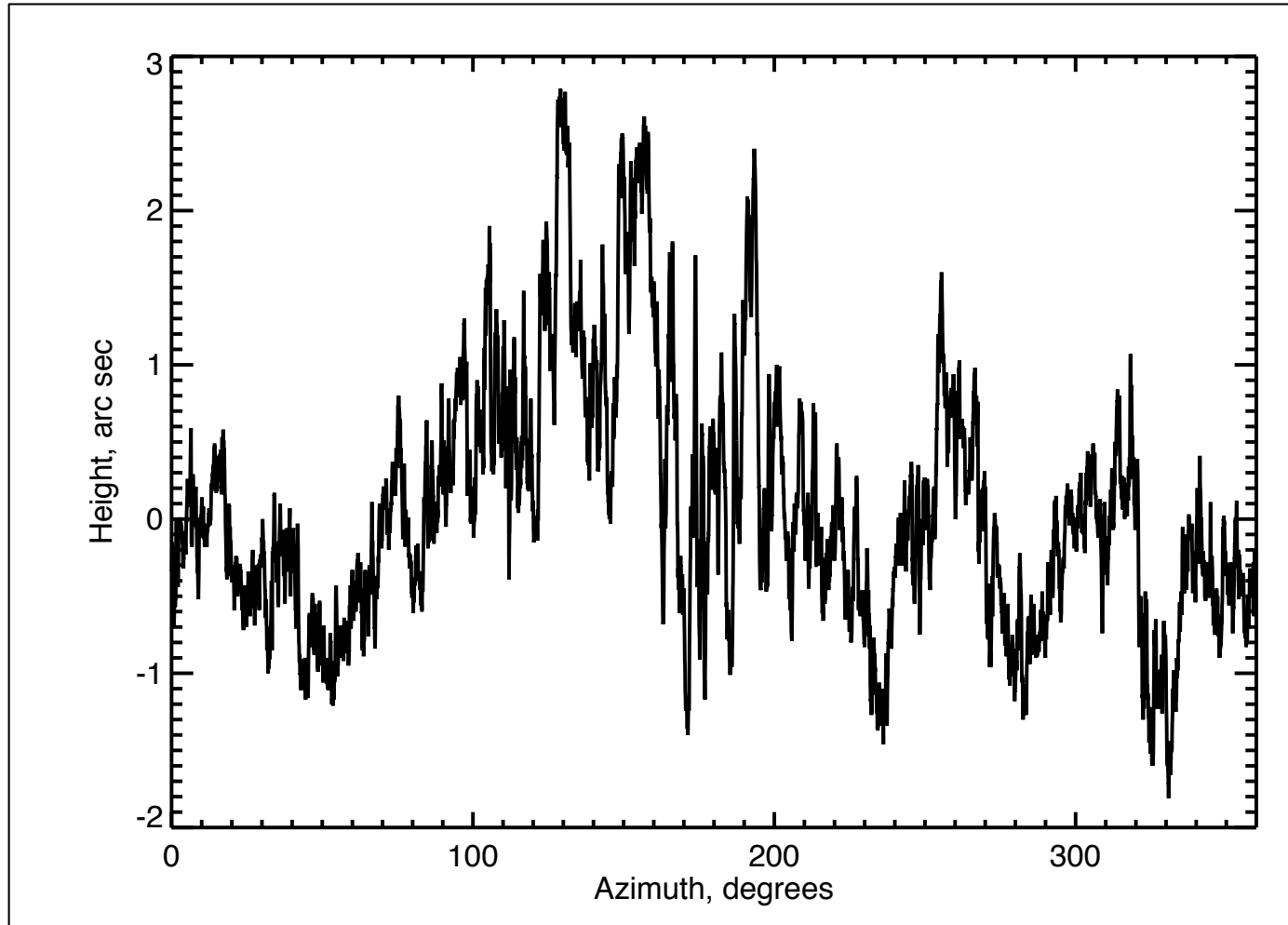
- Locally at the Sun, it's the anisotropy of the radiation
- In an image of the Sun, it's the fall-off of brightness towards the edge.
- At highest precision, it maps the solar structure both vertically and also horizontally (“rugosity”; hills and valleys resulting from convective flow patterns and magnetism)

# Selenography I



Watts, 1963: 0.2" binning

# Selenography II



*Lunar Reconnaissance Observatory: 0.05'' binning*  
(courtesy Ernie Wright, NASA/GSFC)



# Watts-level simulations I

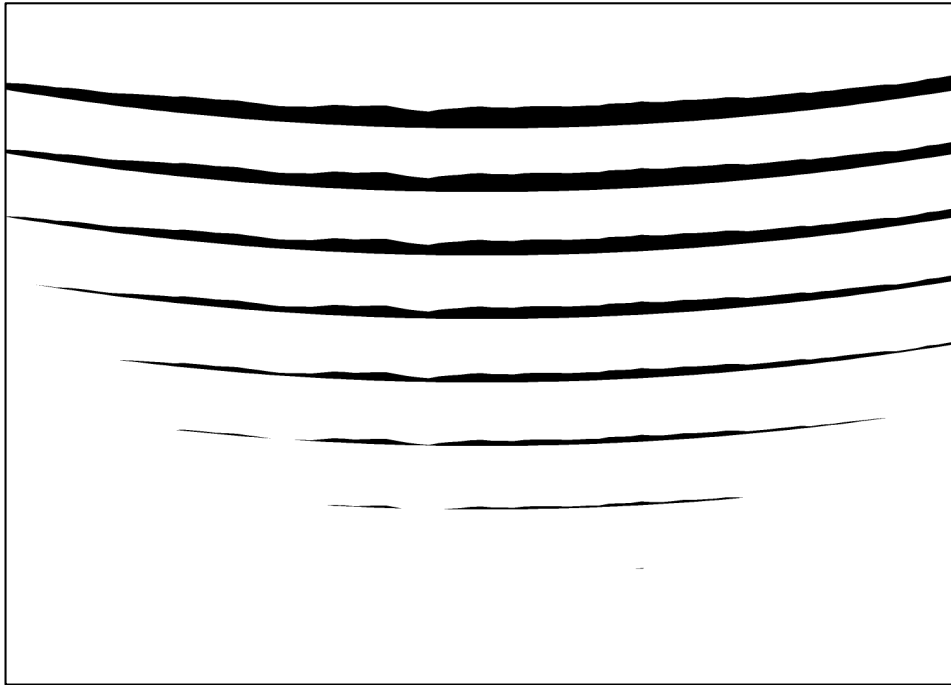


Image intervals 1 s spacing

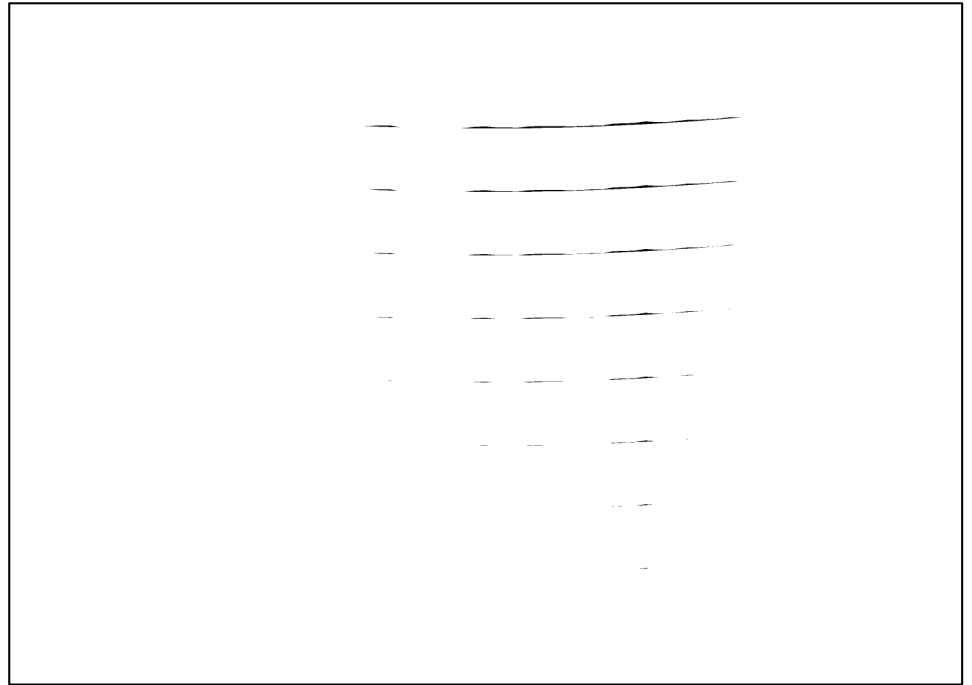
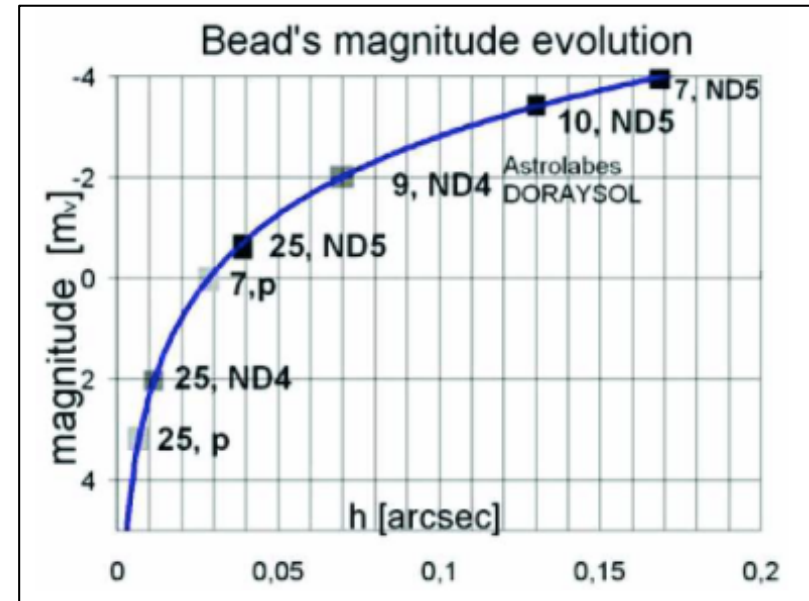
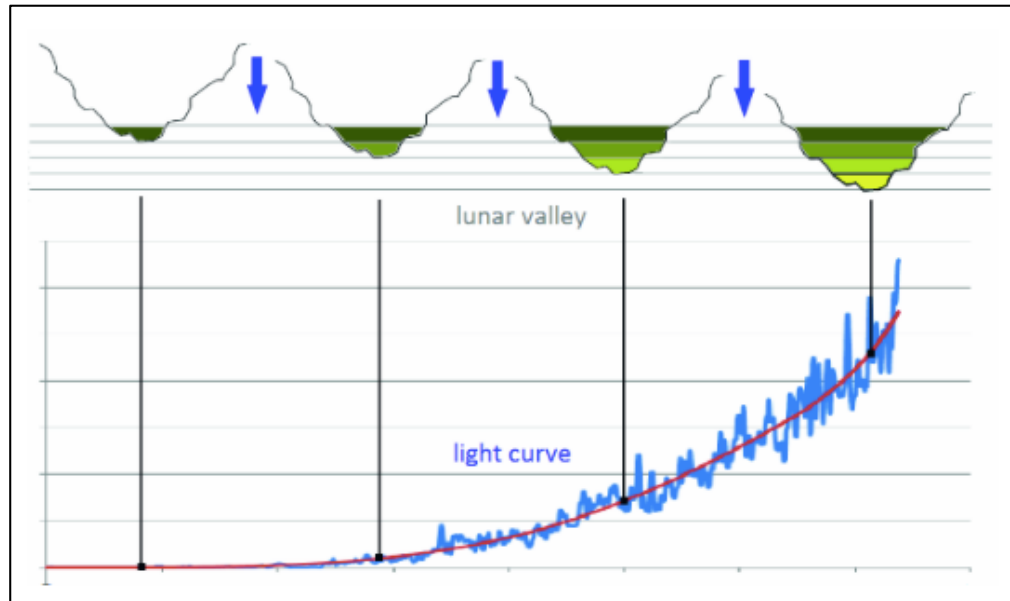


Image intervals 0.1 s spacing

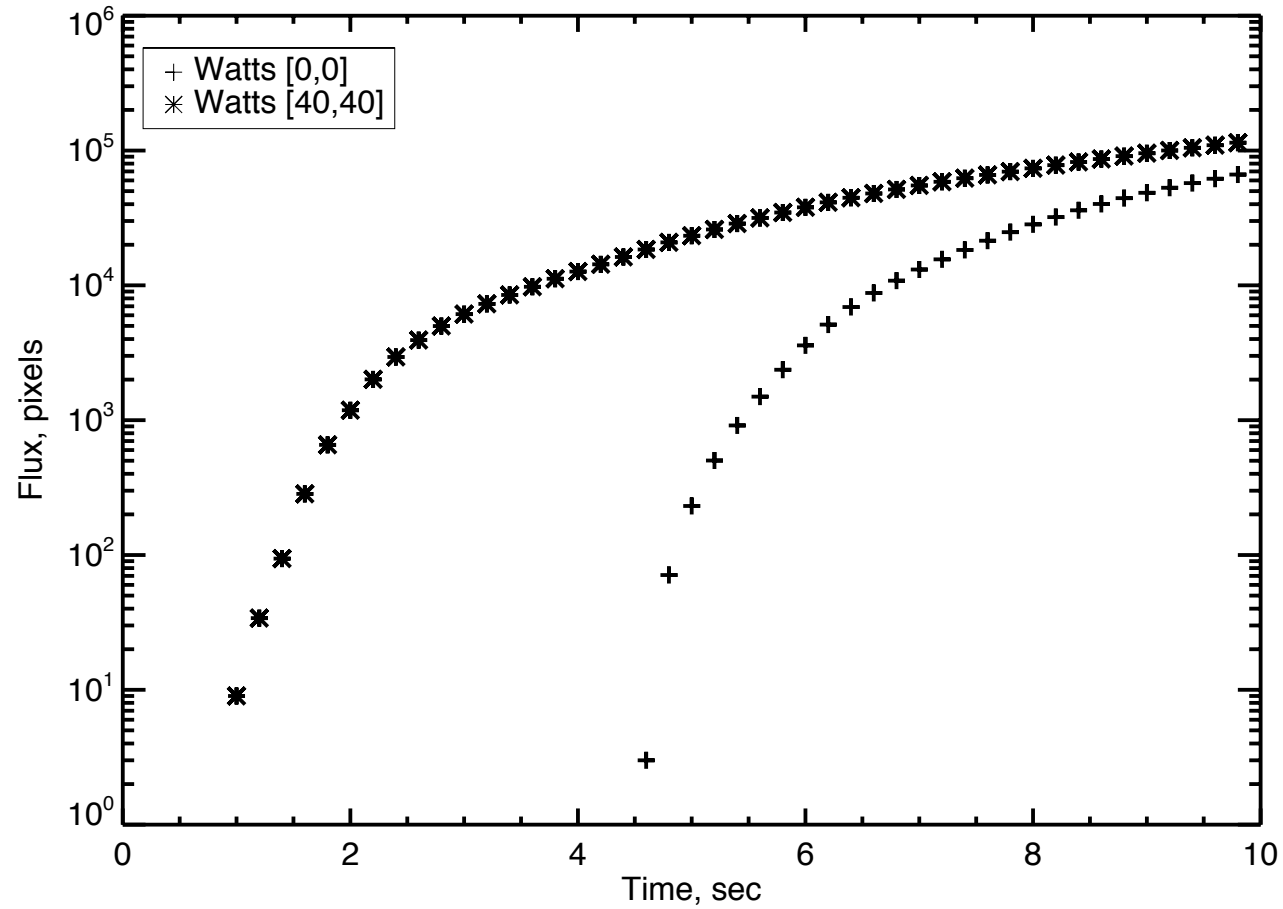
The final point on the right, in the last 100 msec,  
might have a stellar magnitude  $m_V \sim -5$

# Time-series behavior

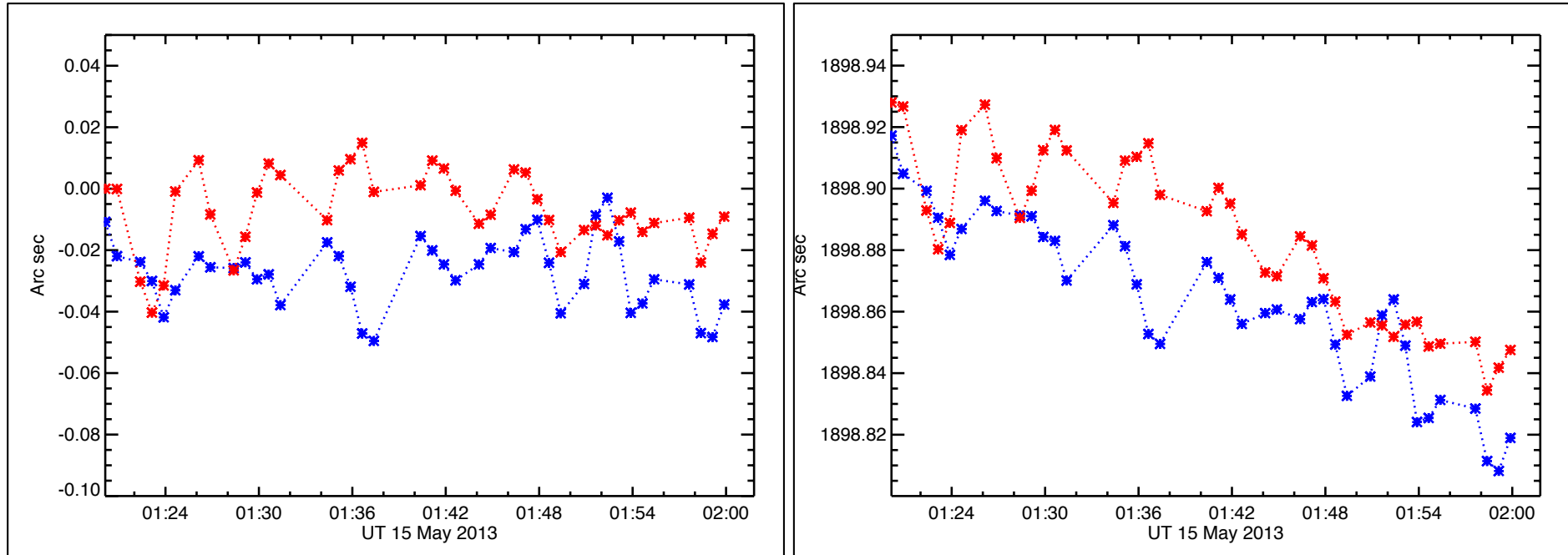


Raponi-Sigismondi 2012

# Watts-level simulations II



# The radius of the Sun

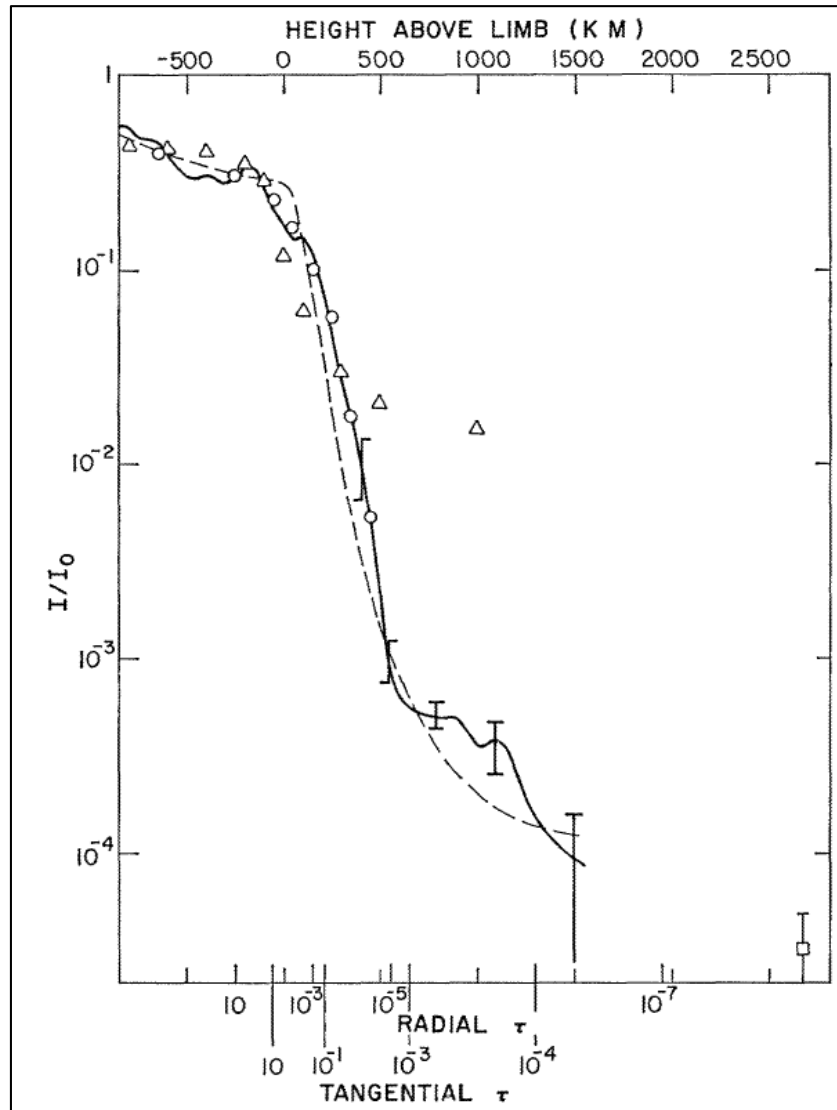


- HMI white-light observations – the best from space
- NS (red) and EW (blue) diameters vs. time
- Left, residuals; right, actual (including Earth orbit)
- p-mode oscillations clearly visible
- How much of this variation is truly from vertical motions, and how much from limb darkening?

# The radius of the Sun: Why is it important?

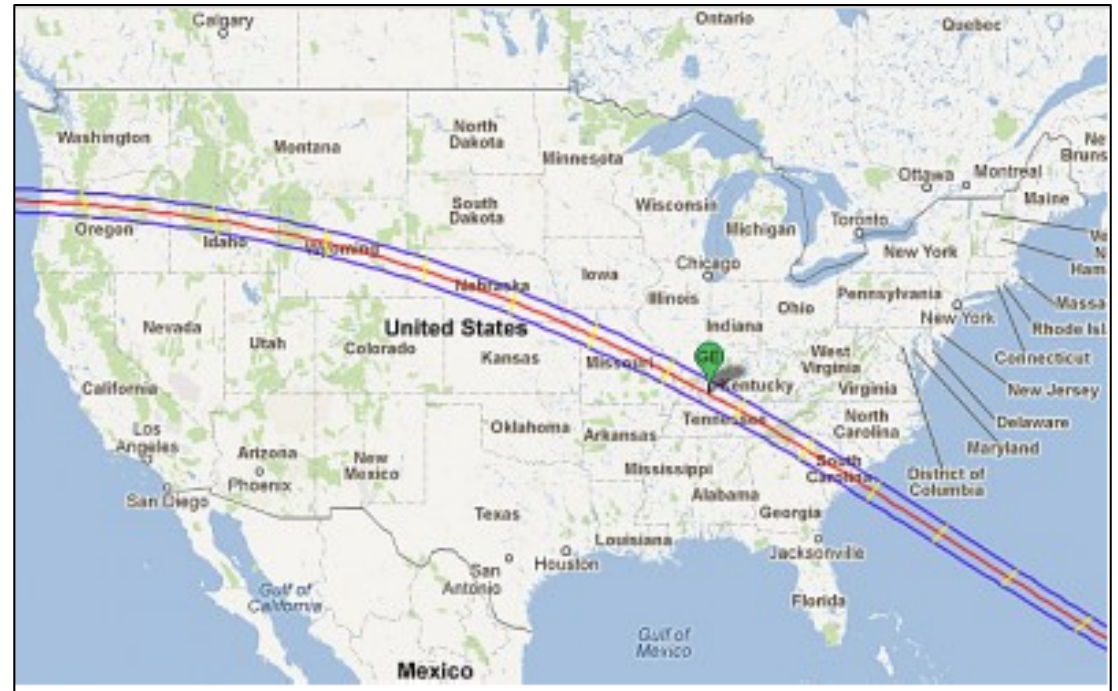
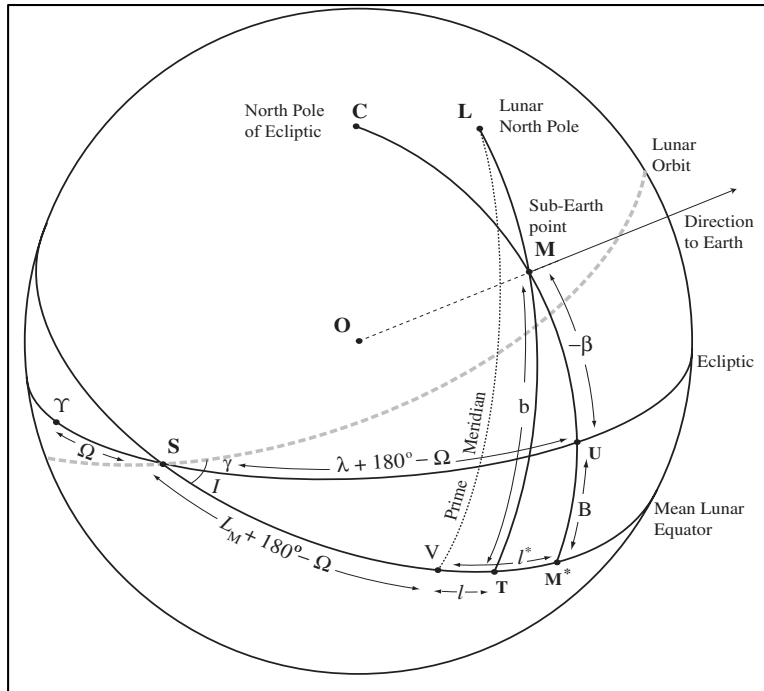
- It's a basic astronomical quantity, meaning that improved values are always important (cf. the Vulcan, Le Verrier, Neptune, and Einstein story)
- There could be cyclic or secular changes
- Past data have suggested this, but now for the first time we can do a time series

# The real world I: How bright is the chromosphere?



- Data from Weart & Faller, 1969
- “Red continuum” specific intensity at about 1% of the Bead
- Expect irregular time-series background from this
- Stray light (even clouds) should be relatively constant in time

# The geometry



The app needs precise time, and precise position as well.

For both problems we rely upon GPS metadata.

# Conclusions

- There's good science
- There's good movies
- The app has its work cut out for it
- We must advertise to get lots of data