



Sperm Whales, Candles and Planet Venus

*An investigation of John Isaac Plummer's 1876
estimation of the brightness of Venus*

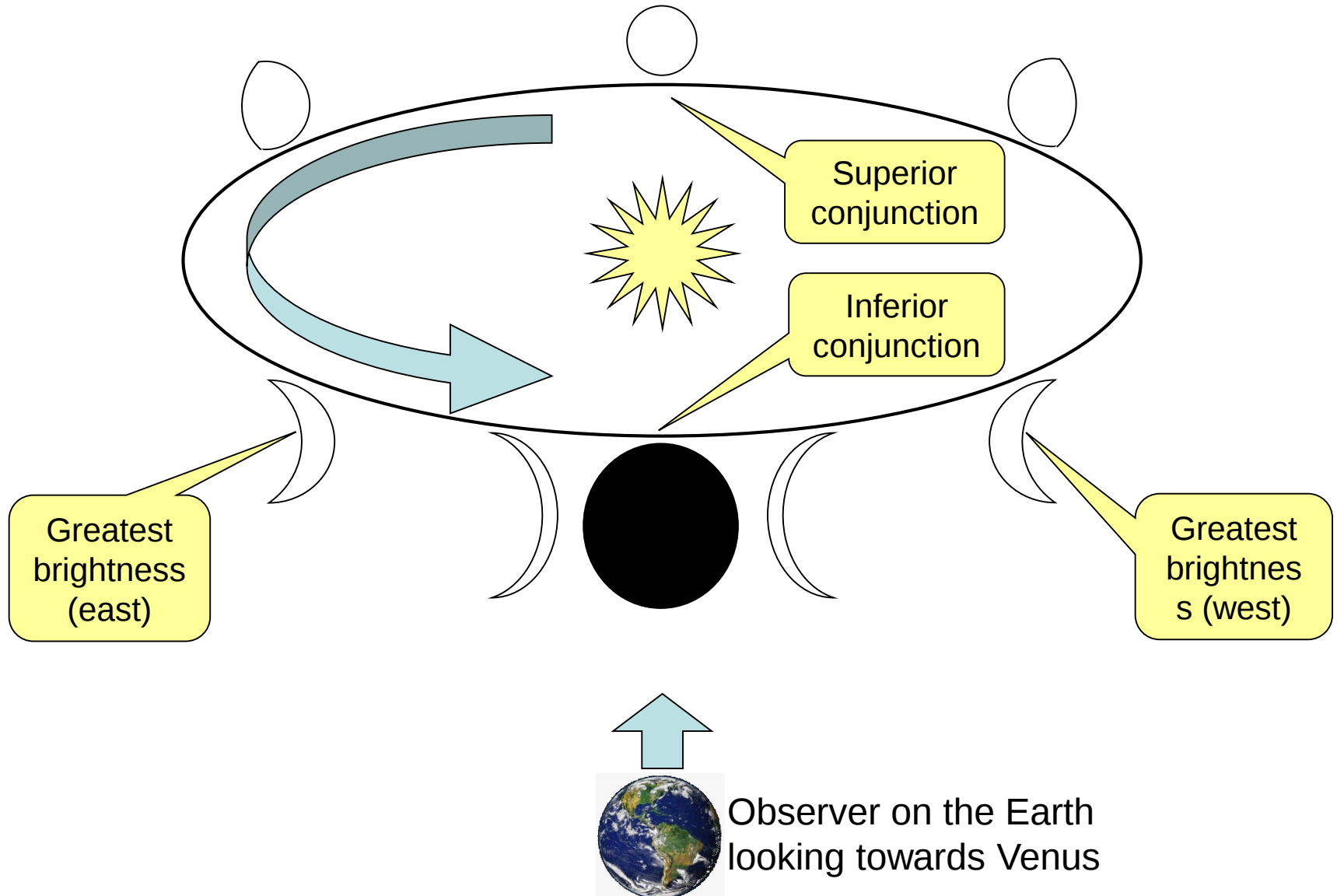
James Appleton

John Isaac Plummer (1845 – 1925)

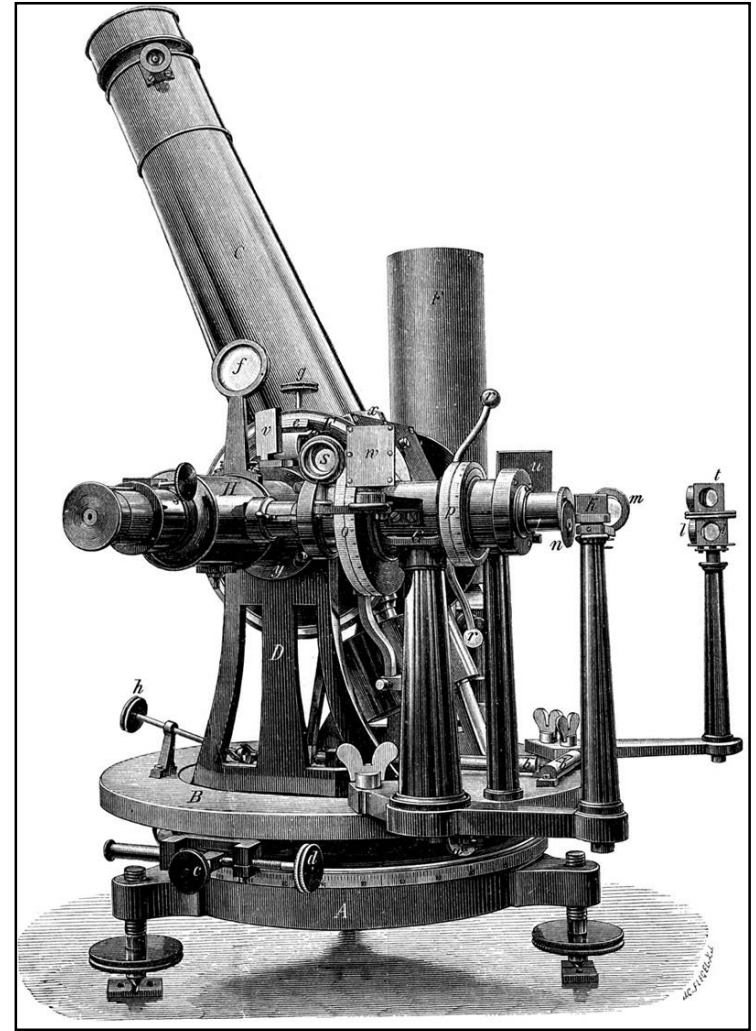
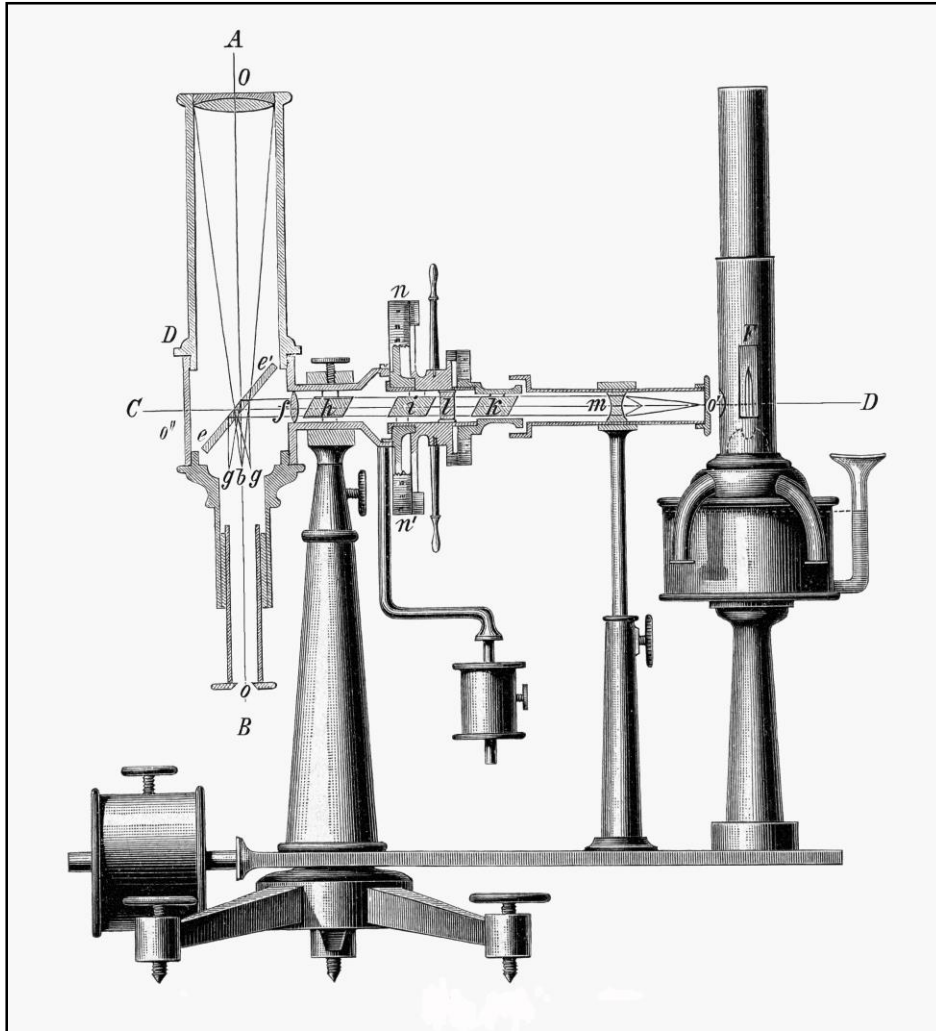
In a photograph
believed to have
been taken
around 1900,
while he worked
at Hong Kong
Observatory



Phases of Venus

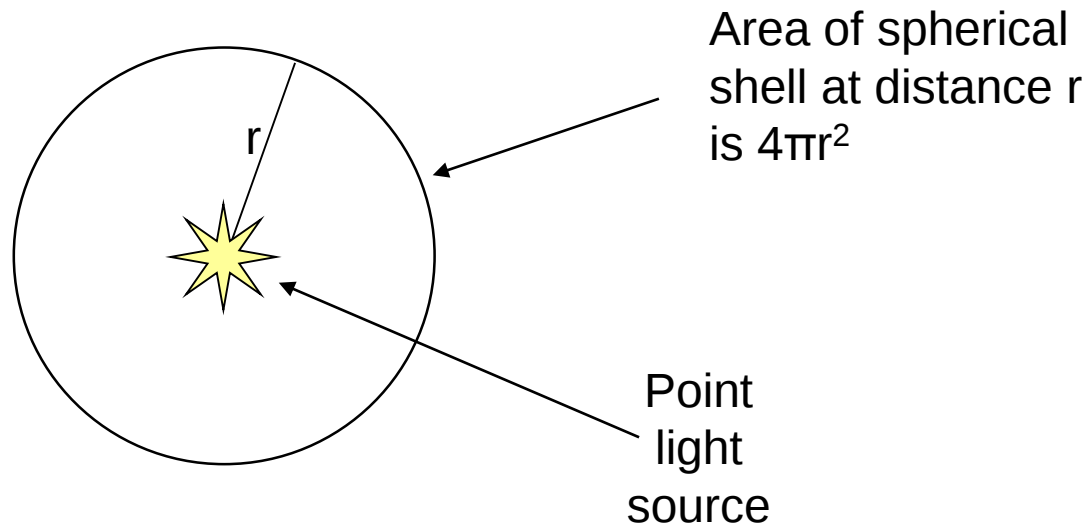


Zoellner Photometer, 1860



The Inverse Square Law of Illumination

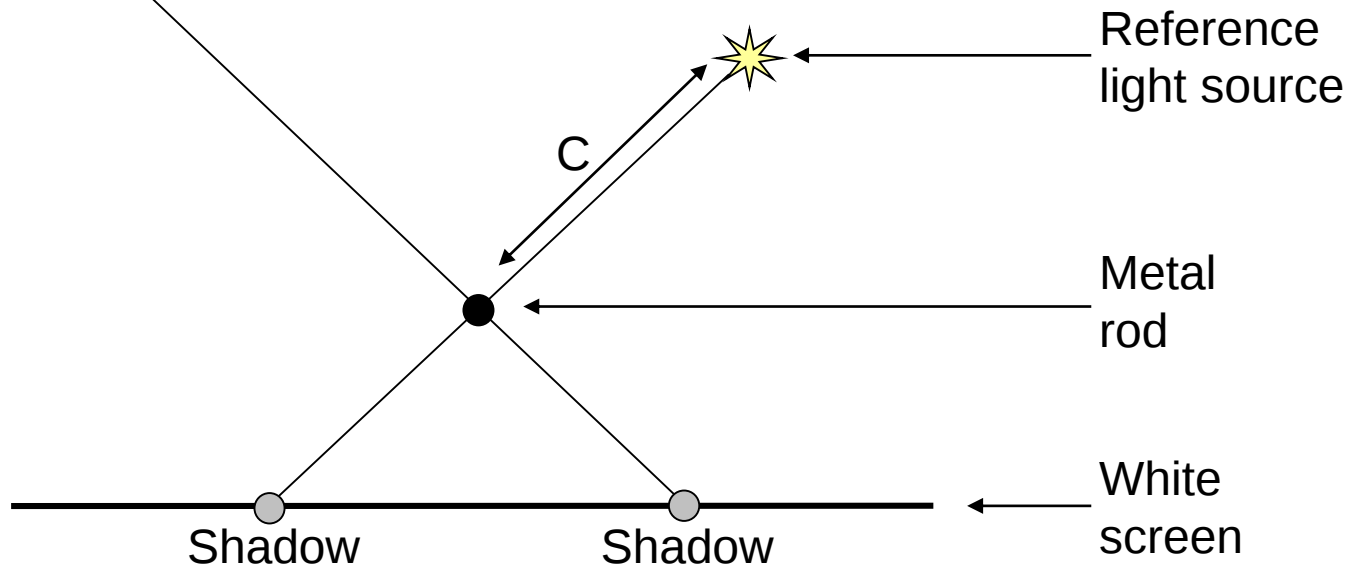
- For a point light source (like a distant star) the flux of light per unit area varies as the inverse square of the distance



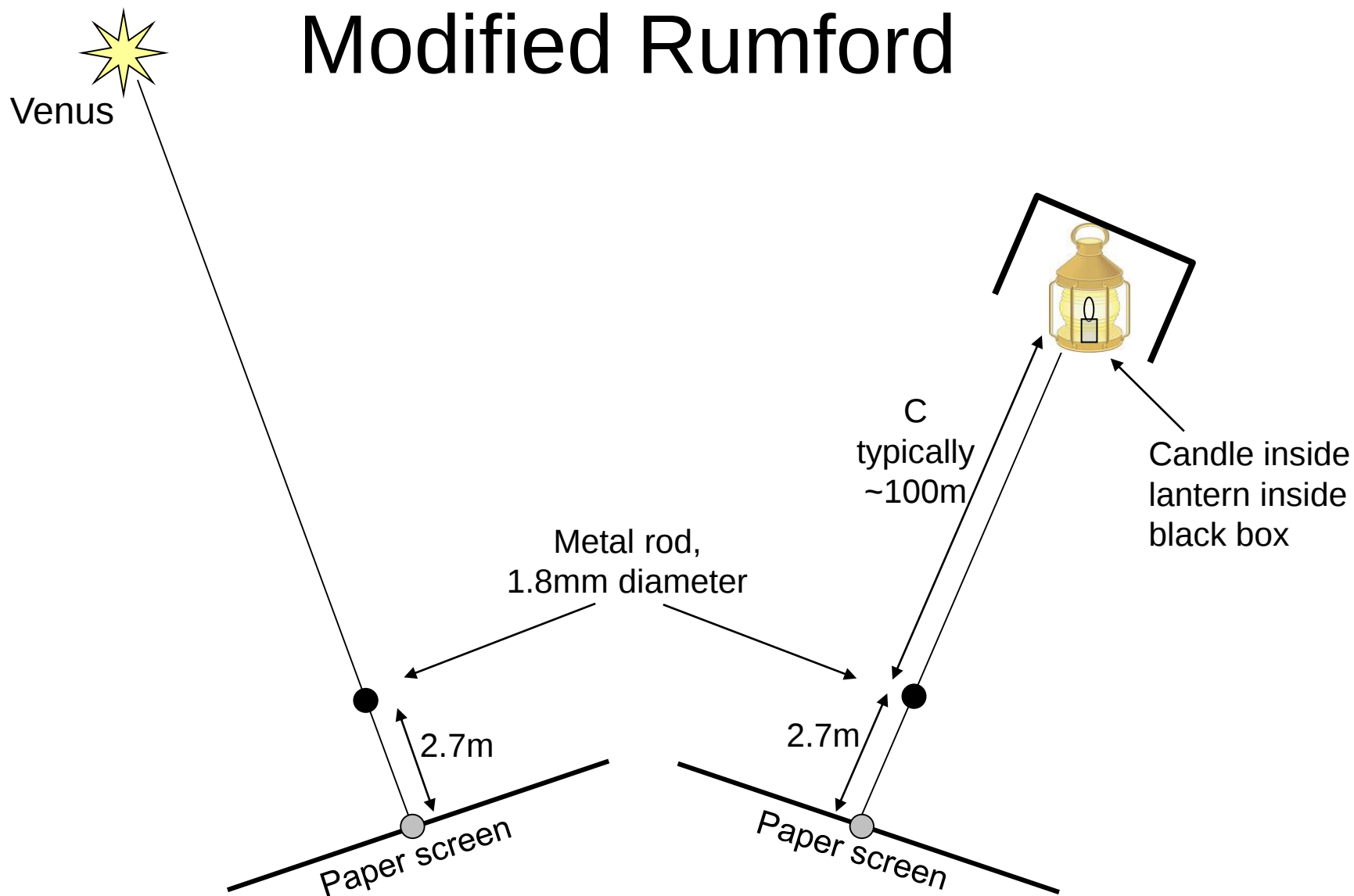
Rumford Photometer

Vary distance, C , to reference light source until shadows are of equal intensity.
 $1/C^2$ is then a measure of the brightness of X in terms of the brightness of the reference light source.

X = light source
of intensity to
be measured



Plummer's Photometer – Modified Rumford



The Reference Light Source

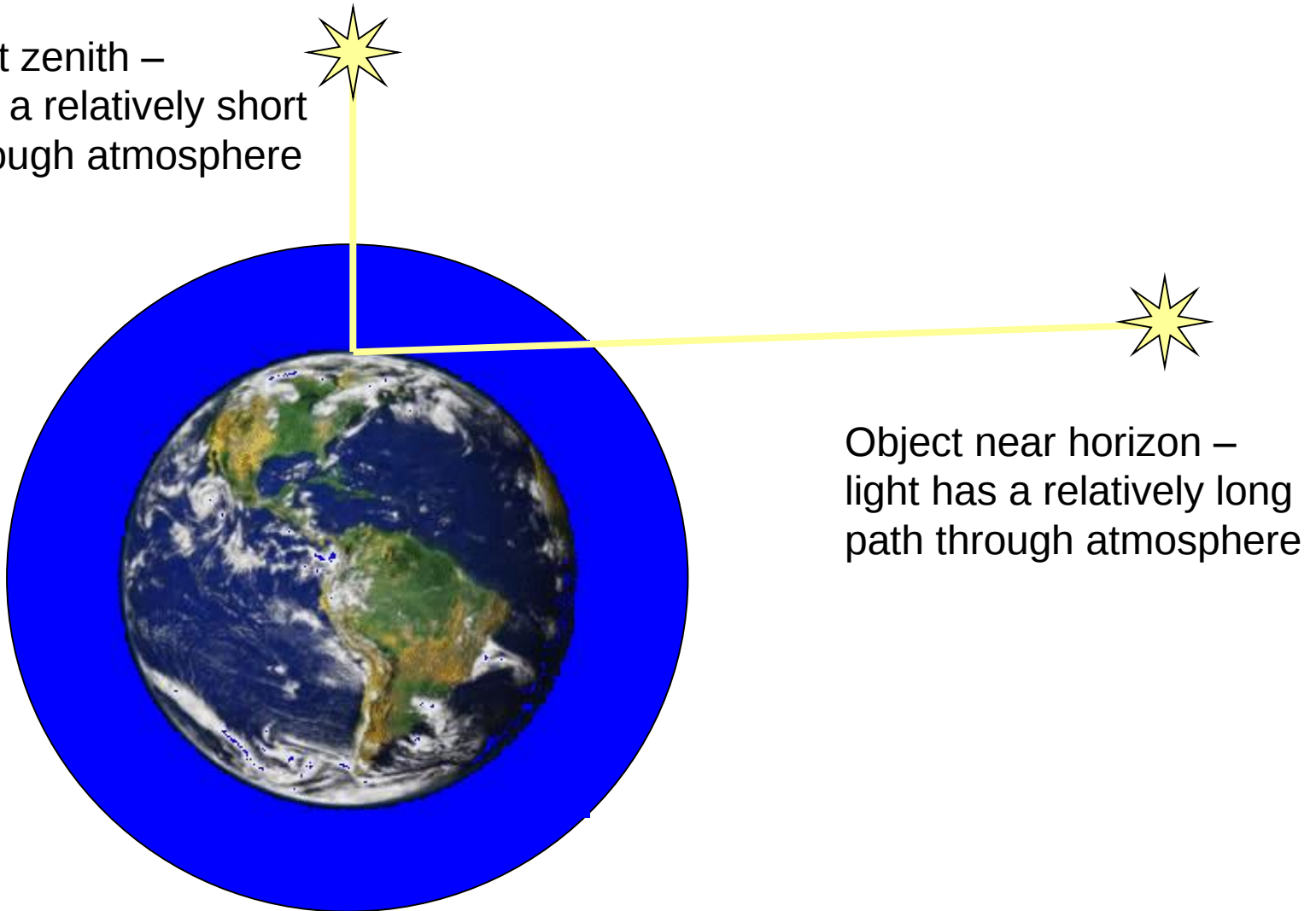


Observations of Venus, 1876

Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)
20 Mar	20:40	12.7	291
24 Mar	20:44	13.5	335
14 Apr	20:52	19.7	286
21 Apr	20:59	20.3	264
23 Apr	21:06	19.6	306
26 Apr	21:22	17.8	265
11 May	21:46	15.5	275
13 May	22:26	6.6	314

Atmospheric Extinction

Object at zenith –
light has a relatively short
path through atmosphere



Object near horizon –
light has a relatively long
path through atmosphere

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Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)
20 Mar	20:40	12.7	291
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Data Analysis

1. Inspect & discard bad data
2. Square values C and adjust for atmospheric extinction
3. Adjust for planetary geometry
4. Plot brightness of Venus against phase

Inspect & Discard Bad Data

Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)	
20 Mar	20:40	12.7	291	
24 Mar	20:44	13.5	335	
14 Apr	20:52	19.7	286	
21 Apr	20:59	20.3	264	
23 Apr	21:06	19.6	306	
26 Apr	21:22	17.8	265	Moonlight interfered
11 May	21:46	15.5	275	
13 May	22:26	6.6	314	Altitude too low

Remaining Observations

Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)
20 Mar	20:40	12.7	291
24 Mar	20:44	13.5	335
14 Apr	20:52	19.7	286
21 Apr	20:59	20.3	264
23 Apr	21:06	19.6	306
11 May	21:46	17.8	275

Square C and Adjust for Atmospheric Extinction

Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)	C² corr. for E (ft²)	E = Atmospheric extinction
20 Mar	20:40	12.7	291	148,400	
24 Mar	20:44	13.5	335	107,500	
14 Apr	20:52	19.7	286	115,800	
21 Apr	20:59	20.3	264	133,900	
23 Apr	21:06	19.6	306	135,600	
11 May	21:46	17.8	275	144,700	

Adjust for Planetary Geometry

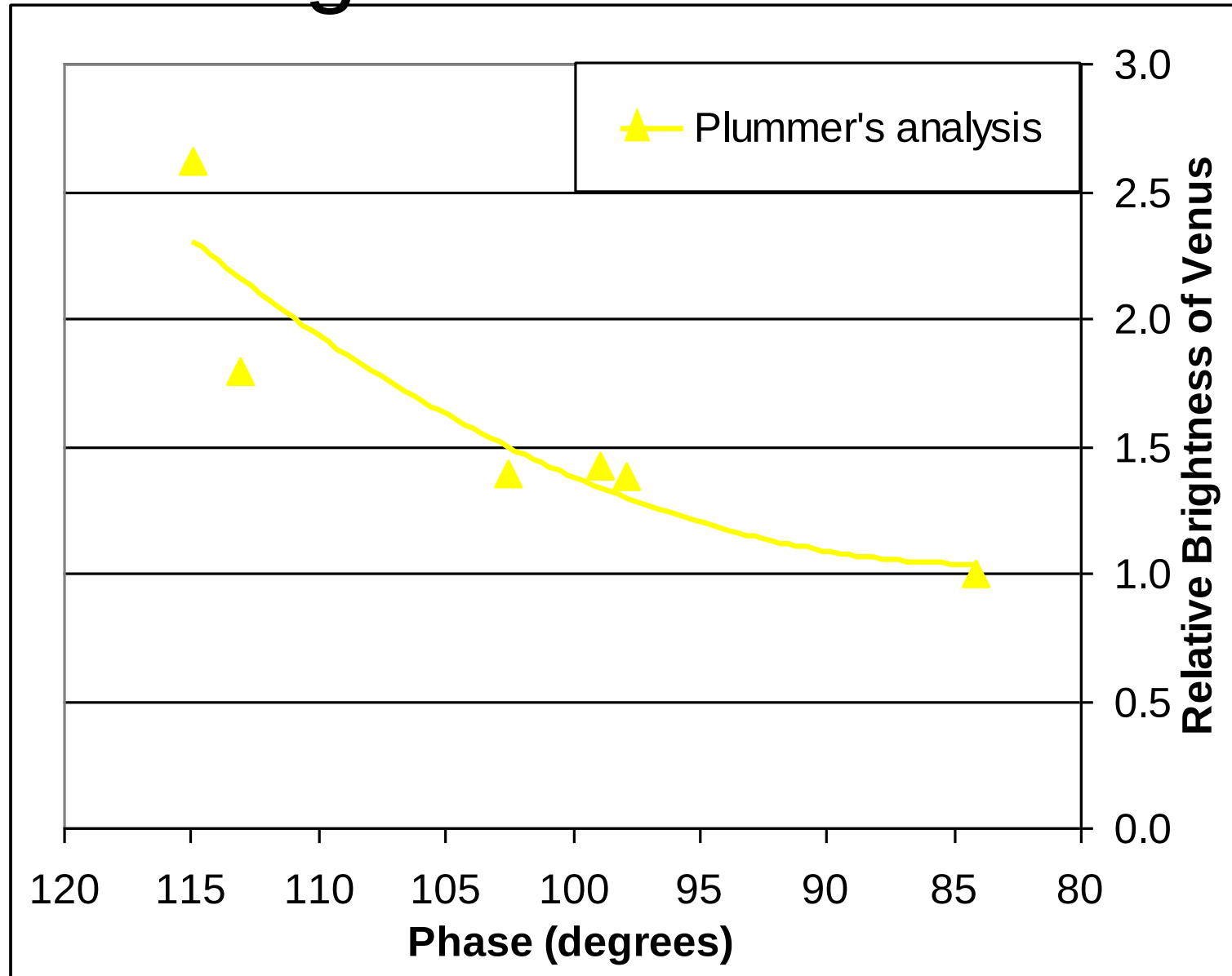
Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)	C ² corr. for E (ft ²)	C ² corr. for E & G (ft ²)
20 Mar	20:40	12.7	291	148,400	165,900
24 Mar	20:44	13.5	335	107,500	113,800
14 Apr	20:52	19.7	286	115,800	88,300
21 Apr	20:59	20.3	264	133,900	89,900
23 Apr	21:06	19.6	306	135,600	87,600
11 May	21:46	17.8	275	144,700	63,300

G =
Planetary
Geometry

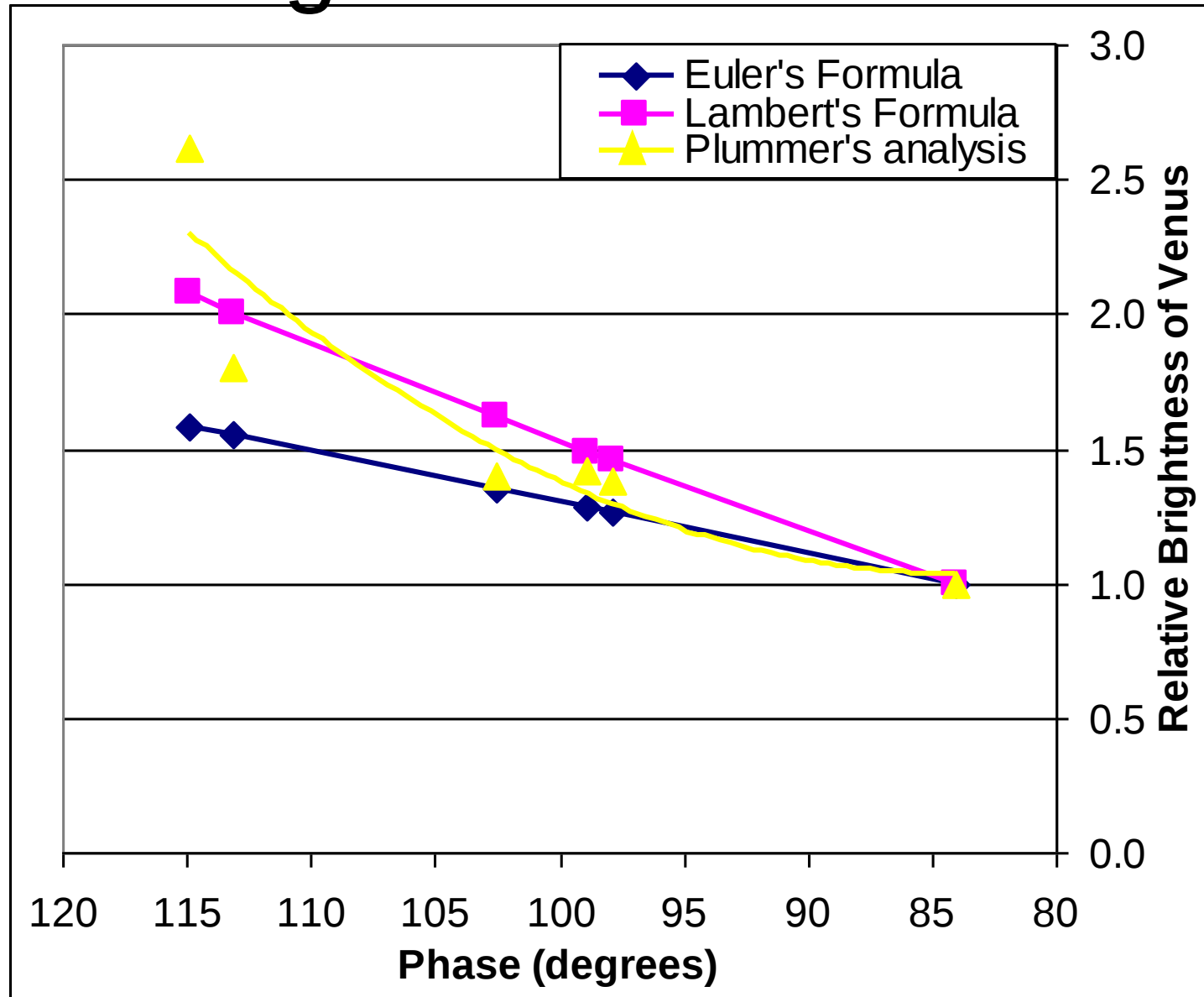
Brightness vs Phase

Date (1876)	Time (UT)	Alt (deg)	C = Dist to candle (ft)	C² corr. for E (ft²)	C² corr. for E & G (ft²)	Phase of Venus (°)
20 Mar	20:40	12.7	291	148,400	165,900	115
24 Mar	20:44	13.5	335	107,500	113,800	113
14 Apr	20:52	19.7	286	115,800	88,300	103
21 Apr	20:59	20.3	264	133,900	89,900	99
23 Apr	21:06	19.6	306	135,600	87,600	98
11 May	21:46	17.8	275	144,700	63,300	84

Brightness vs Phase



Brightness vs Phase



*Now let's look at some
practical aspects...*

And the conclusions are...

Skyglow Around Jupiter

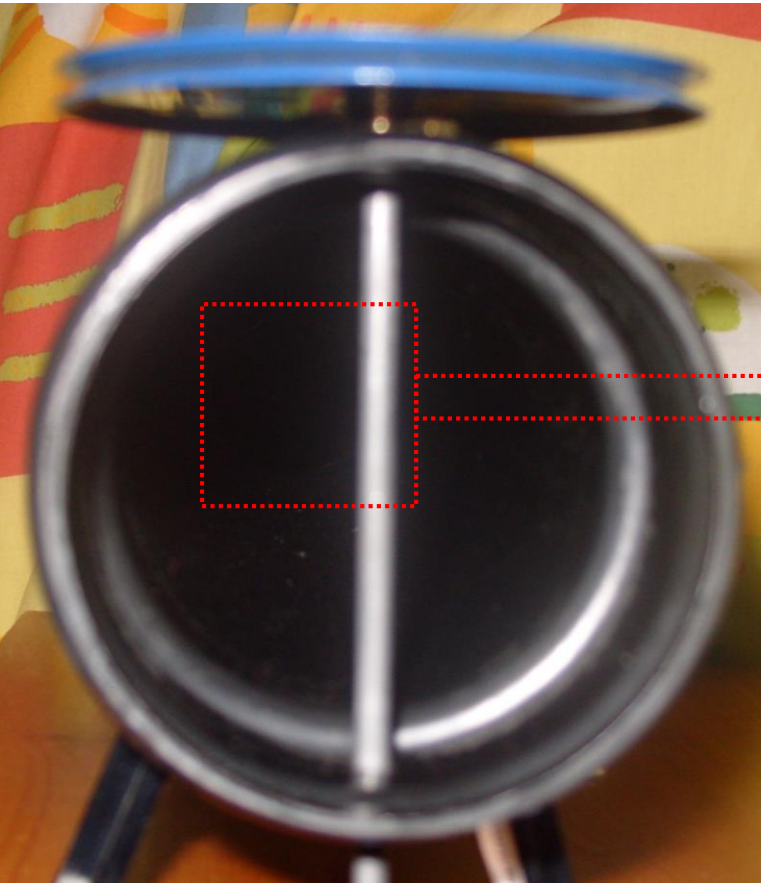


27 Sep 2008
21:20 UT
Jupiter mag -2.3

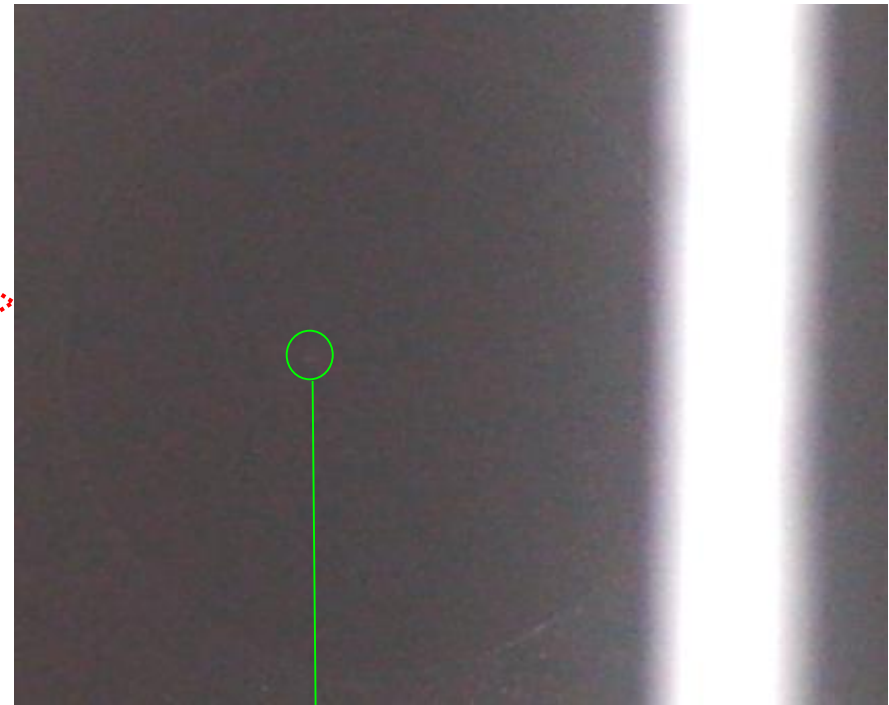
The Photometer in Use



Looking Down the Tube

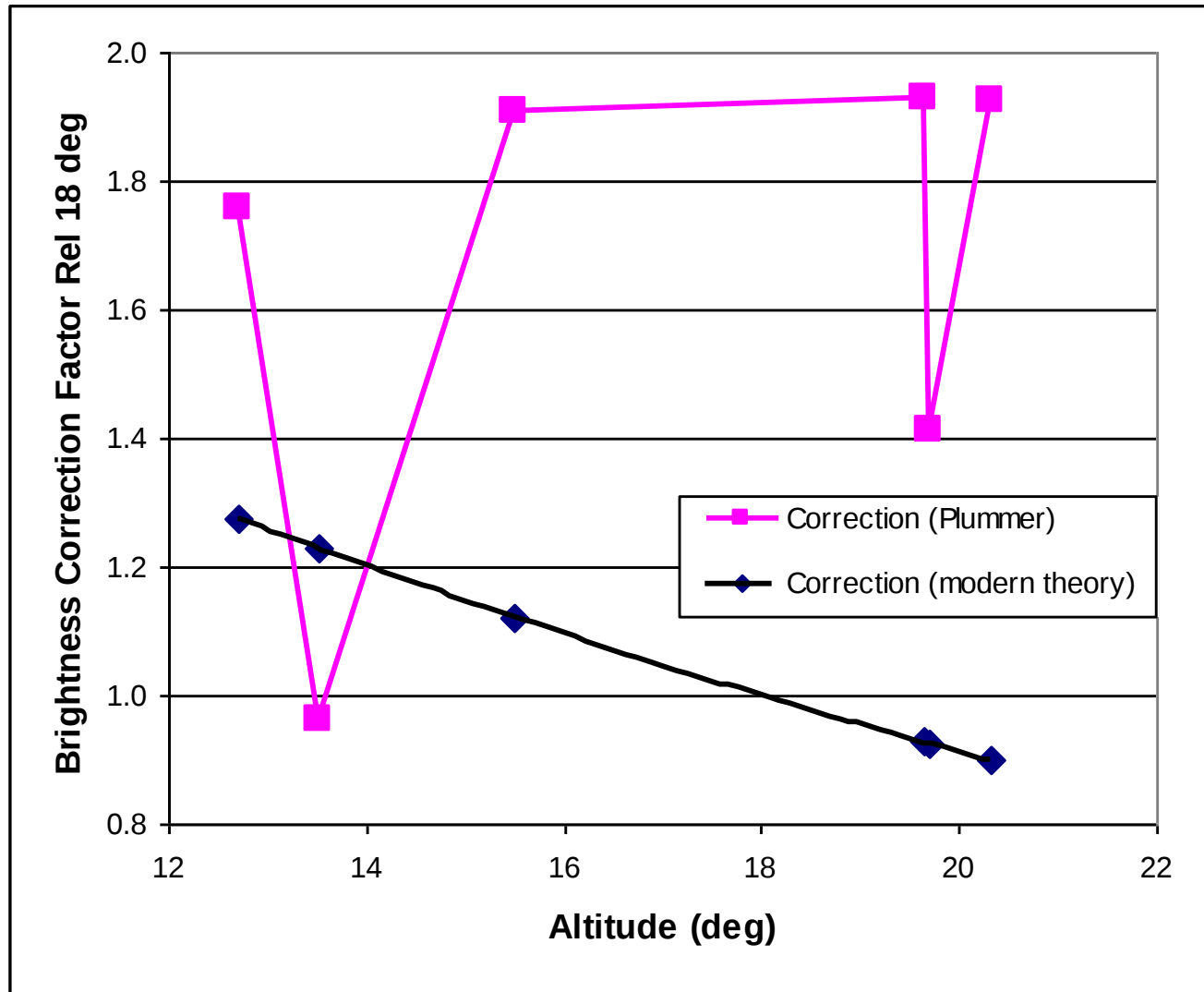


24 Aug 2008
21:03 UT



Jupiter
mag -2.6

Atmospheric Extinction Factors



Brightness vs Phase

