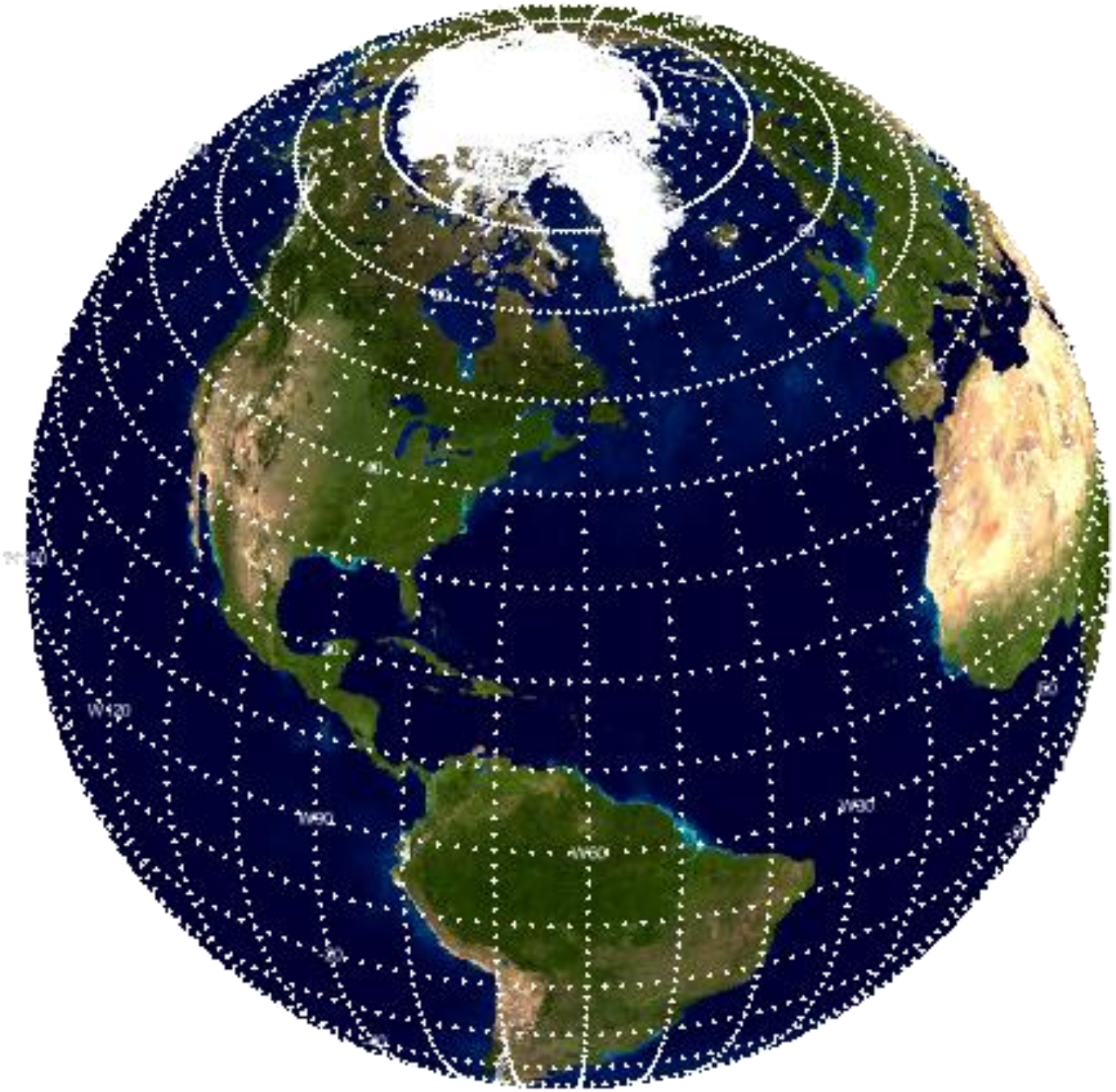
ENGI 128

INTRODUCTION TO ENGINEERING SYSTEMS

Lecture 16:
Global Coordinates II

"Understand Your Technical World"


Longitude


W120
W90
W60

We take the lines on the earth for granted…

But it was one of the biggest scientific problems on the modern age

Paralement created the The Longitude Act of 1714 to solve this problem

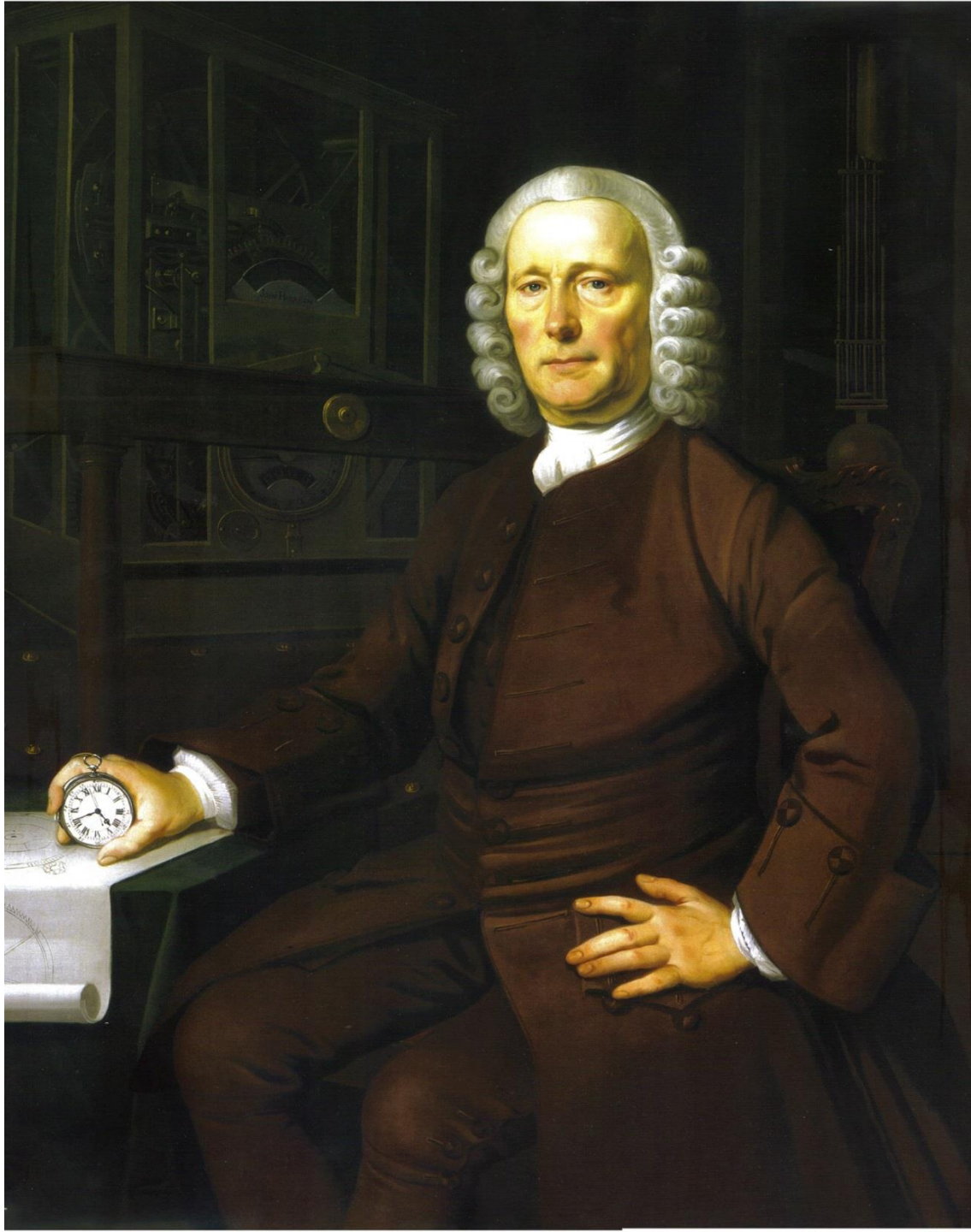
Had a cash prize of 20,000 pounds
(4.53 million dollars on 2008)

[Longitude viewing]

John Harrison

1693-1776

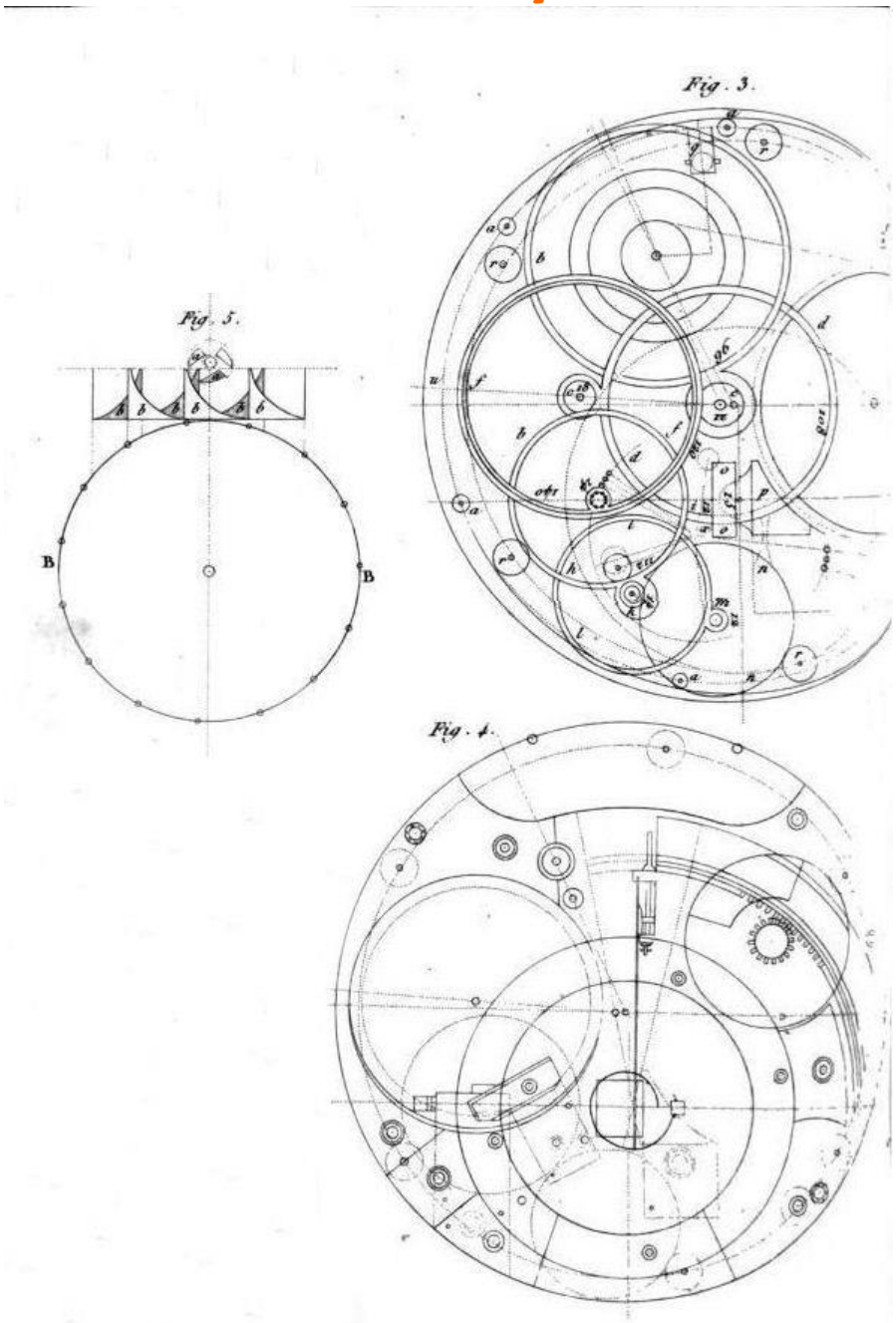
One of the greatest engineers of all time.



Harrison H1

Harrison H4

Brains and Beauty



[vacation pictures]

Other ways to tell time from the heavens?

Star positions?

How can you know where the stars will be?

Location: W093 16, N44 58

MINNEAPOLIS, MINNESOTA
Astronomical Twilight for 2009

Central Standard Time

Astronomical Applications Dept.
U. S. Naval Observatory
Washington, DC 20392-5420

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
01	0605	1829	0552	1902	0513	1938	0412	2023	0305	2117	0206	2217	0200	2233	0254	2144	0350	2035	0434	1931	0512	1840	0546	1818
02	0605	1830	0551	1904	0511	1940	0409	2025	0303	2119	0205	2219	0201	2232	0256	2142	0352	2032	0435	1929	0514	1839	0547	1818
03	0605	1831	0550	1905	0510	1941	0407	2026	0301	2121	0203	2220	0202	2232	0257	2139	0353	2030	0436	1927	0515	1838	0548	1818
04	0605	1831	0549	1906	0508	1943	0405	2028	0258	2123	0202	2222	0204	2231	0259	2137	0355	2028	0437	1925	0516	1837	0549	1818
05	0605	1832	0548	1907	0506	1944	0403	2030	0256	2125	0201	2223	0205	2230	0301	2135	0356	2026	0439	1923	0517	1836	0550	1818
06	0605	1833	0547	1909	0504	1945	0401	2031	0254	2127	0200	2225	0206	2228	0303	2133	0358	2023	0440	1921	0518	1834	0551	1818
07	0605	1834	0545	1910	0502	1947	0359	2033	0252	2129	0159	2226	0208	2227	0305	2131	0400	2021	0441	1919	0520	1833	0552	1818
08	0605	1835	0544	1911	0501	1948	0356	2035	0250	2131	0158	2227	0209	2226	0307	2129	0401	2019	0443	1917	0521	1832	0553	1818
09	0605	1836	0543	1912	0459	1949	0354	2036	0248	2133	0157	2228	0211	2225	0309	2126	0403	2017	0444	1916	0522	1831	0553	1818
10	0605	1837	0542	1914	0457	1951	0352	2038	0246	2135	0156	2230	0212	2223	0311	2124	0404	2014	0445	1914	0523	1830	0554	1818
11	0605	1838	0540	1915	0455	1952	0350	2040	0243	2137	0156	2231	0214	2222	0313	2122	0406	2012	0446	1912	0524	1829	0555	1818
12	0604	1839	0539	1916	0453	1954	0347	2042	0241	2139	0155	2232	0216	2221	0315	2120	0407	2010	0448	1910	0525	1829	0556	1818
13	0604	1840	0538	1917	0451	1955	0345	2043	0239	2141	0155	2232	0217	2219	0317	2117	0409	2008	0449	1909	0527	1828	0556	1818
14	0604	1841	0537	1919	0449	1956	0343	2045	0237	2143	0154	2233	0219	2218	0319	2115	0410	2006	0450	1907	0528	1827	0557	1819
15	0603	1842	0535	1920	0447	1958	0341	2047	0235	2145	0154	2234	0221	2216	0320	2113	0411	2004	0451	1905	0529	1826	0558	1819
16	0603	1843	0534	1921	0445	1959	0338	2049	0233	2147	0153	2235	0223	2214	0322	2111	0413	2001	0453	1904	0530	1825	0558	1819
17	0603	1845	0532	1923	0443	2001	0336	2050	0231	2149	0153	2235	0224	2213	0324	2108	0414	1959	0454	1902	0531	1825	0559	1820
18	0602	1846	0531	1924	0441	2002	0334	2052	0229	2151	0153	2236	0226	2211	0326	2106	0416	1957	0455	1900	0532	1824	0600	1820
19	0602	1847	0529	1925	0439	2003	0332	2054	0227	2153	0153	2236	0228	2209	0328	2104	0417	1955	0456	1859	0534	1823	0600	1820
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21	0600	1849	0526	1928	0435	2006	0327	2058	0224	2157	0153	2236	0232	2206	0331	2059	0420	1951	0459	1856	0536	1822	0601	1821
22	0600	1850	0525	1929	0433	2008	0325	2100	0222	2159	0154	2237	0234	2204	0333	2057	0421	1949	0500	1854	0537	1821	0602	1822
23	0559	1851	0523	1930	0431	2009	0323	2101	0220	2201	0154	2237	0236	2202	0335	2055	0423	1947	0501	1853	0538	1821	0602	1822
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25	0558	1854	0520	1933	0427	2012	0318	2105	0217	2205	0155	2236	0240	2158	0338	2050	0426	1943	0504	1850	0540	1820	0603	1824
26	0557	1855	0518	1934	0425	2014	0316	2107	0215	2207	0156	2236	0242	2156	0340	2048	0427	1941	0505	1848	0541	1820	0604	1824
27	0556	1856	0517	1936	0422	2015	0314	2109	0213	2209	0156	2236	0244	2154	0342	2046	0428	1939	0506	1847	0542	1819	0604	1825
28	0555	1857	0515	1937	0420	2017	0312	2111	0212	2210	0157	2235	0246	2152	0343	2044	0430	1937	0508	1845	0543	1819	0604	1826
29	0555	1859			0418	2019	0309	2113	0210	2212	0158	2235	0248	2150	0345	2041	0431	1935	0509	1844	0544	1819	0604	1826
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31	0553	1901			0414	2022			0207	2216			0252	2146	0348	2037			0511	1842			0605	1828

Add one hour for daylight time, if and when in use.

Other ways to tell time from the heavens?

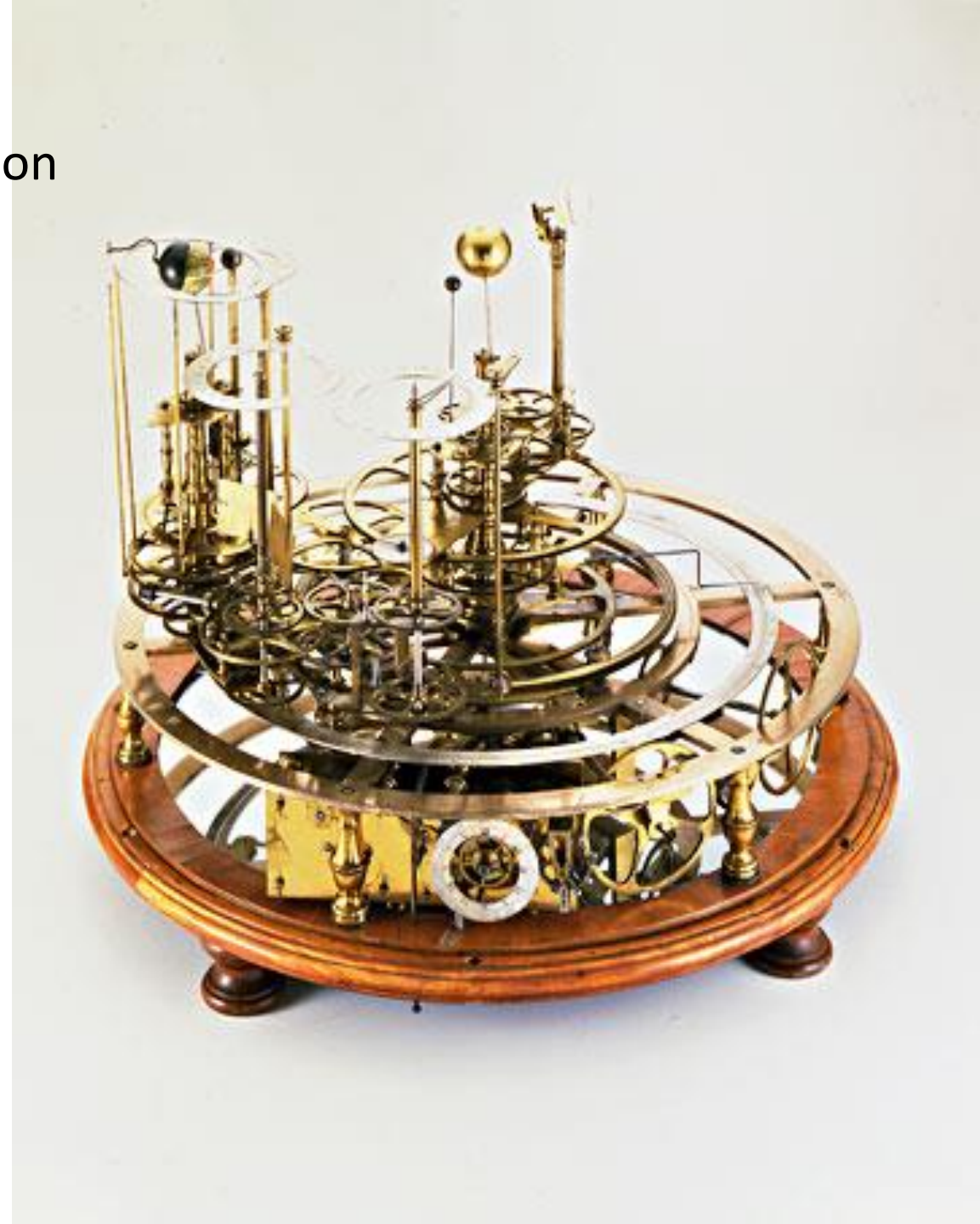
~~Star positions?~~

Planet positions?

The “Grand Orrery”

Designed by James Ferguson

1780



What does a modern Orrery look like?

And how does it work?

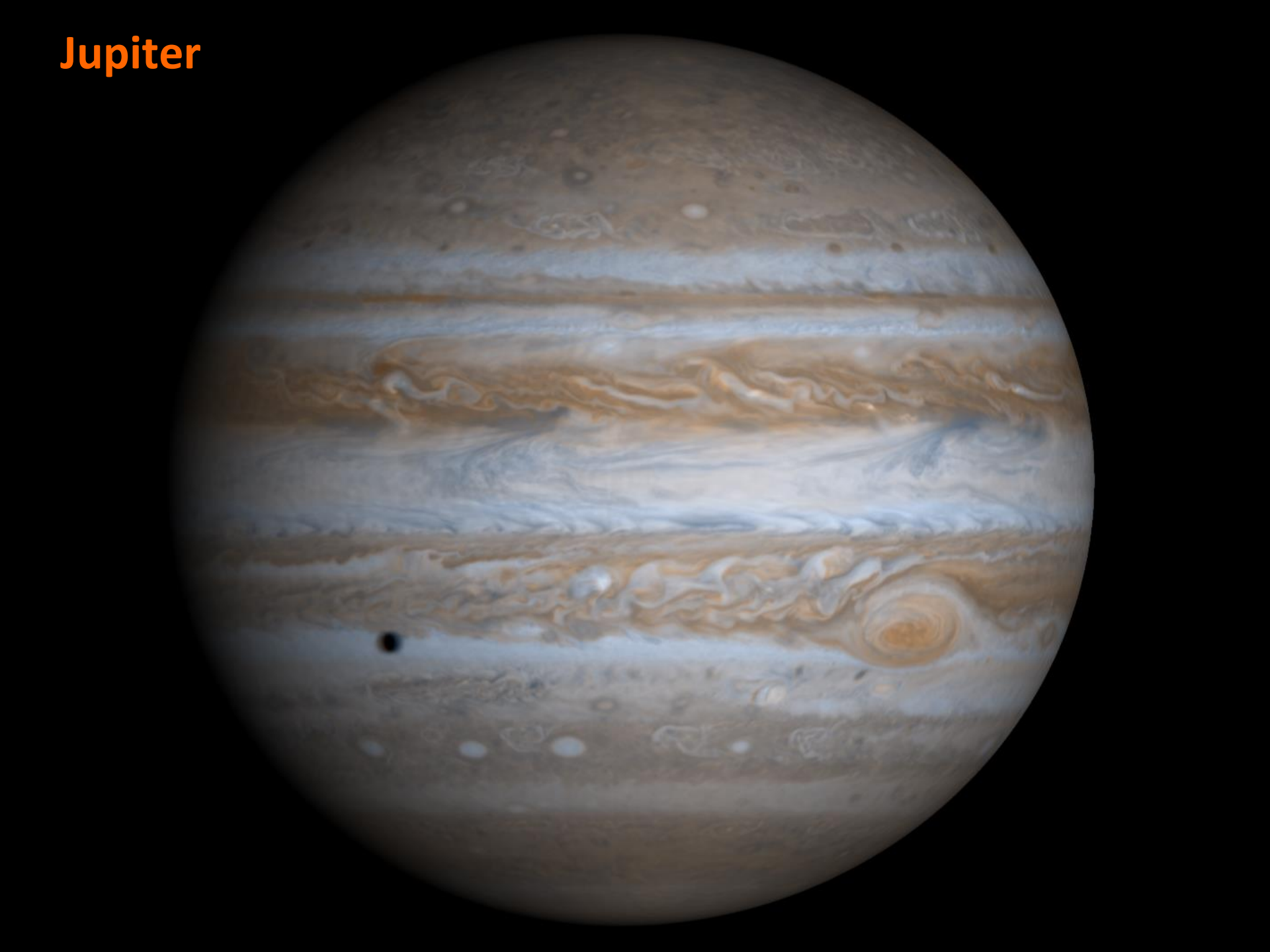
Other ways to tell time from the heavens?

~~Star positions?~~

~~Planet positions?~~

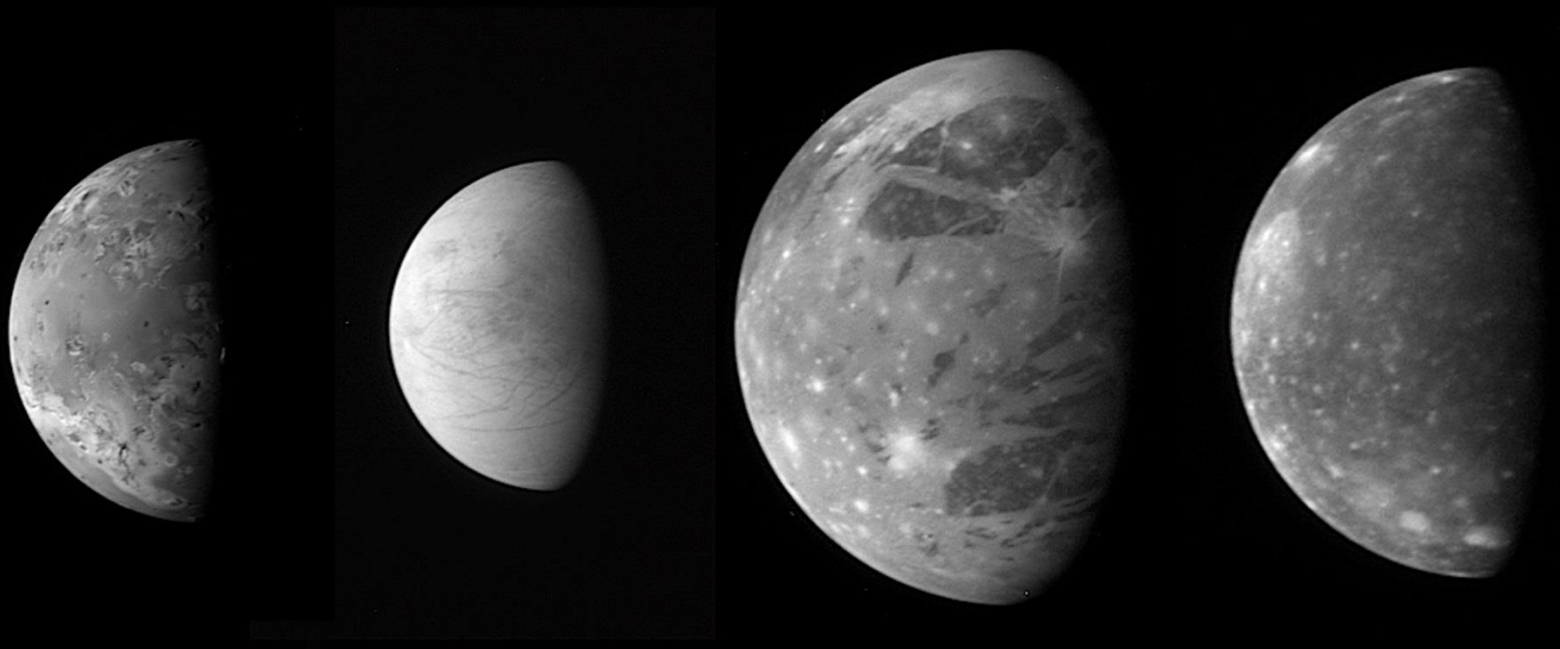
The positions of the moons of planets?

Jupiter



Jupiter and it’s 4 largest moons

Family Portrait



Io Europa Ganymede Callisto

View December's Total Lunar Eclipse p. 58

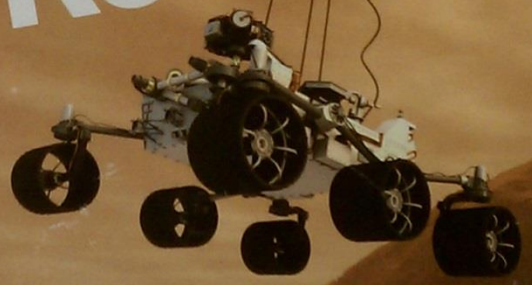
THE ESSENTIAL MAGAZINE OF ASTRONOMY

SKY & TELESCOPE

S&T Test Report:
A Fabulous 4-inch Refractor for $499
p. 52

DECEMBER 2011

NASA's Giant New Mars Rover p. 22



World's Biggest Amateur Asteroid Hunt p. 32

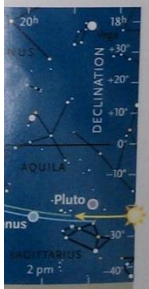
$5.99 US
Display until December 5, 2011
12
0 74808 02207 6

HOW TO:
See Action on Jupiter p. 60
Maximize Your Binocular Viewing p. 38

Visit SkyandTelescope.com

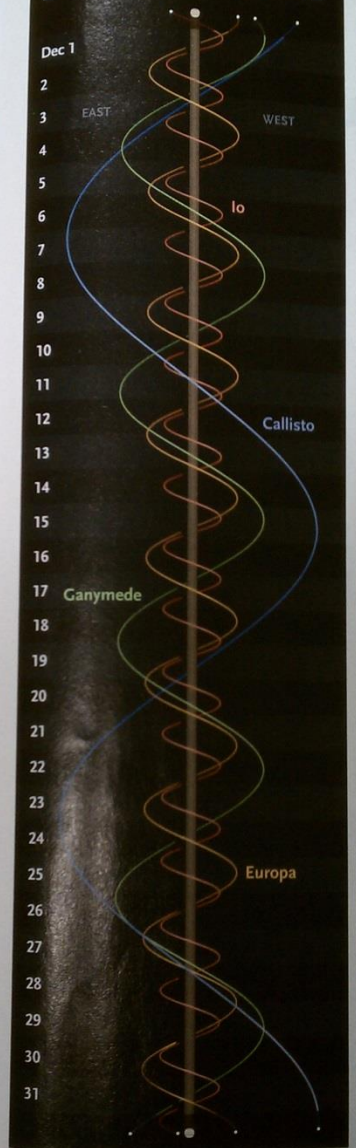
Illumination	Distance
—	0.986
—	0.983
5%	0.694
17%	0.747
57%	0.969
79%	1.166
89%	1.450
87%	1.402
85%	1.351
83%	1.298
90%	1.322
90%	1.185
91%	1.049
100%	4.145
99%	4.528
100%	10.384
100%	9.972
100%	19.933
100%	30.408
100%	33.101

sal Time on selected
magnitude and
age of a planet's disk
–Sun distance, 1 a.u.
com/almanac.
pole currently tilted

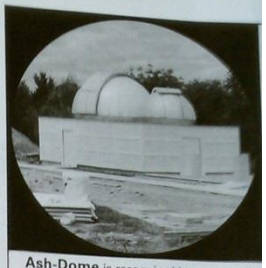


when it's waxing
en they appear due

Jupiter's Moons

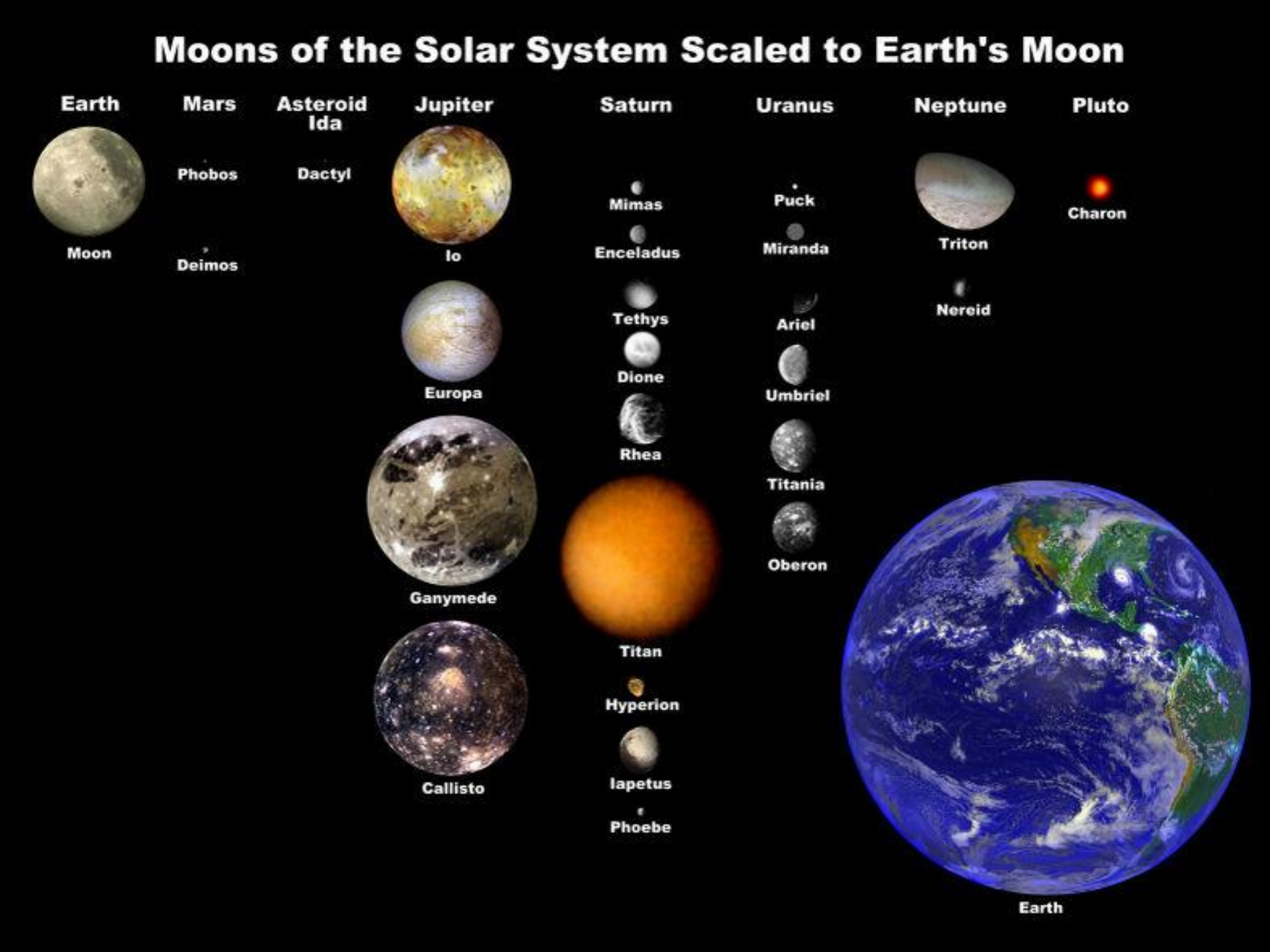


The wavy lines represent Jupiter's four big satellites. The central vertical band is Jupiter itself. Each gray or black horizontal band is one day, from 0h (upper edge of band) to 24h UT (GMT). UT dates are at left. Slide a paper's edge down to your date and time, and read across to see the satellites' positions east or west of Jupiter.



Ash-Dome is recognized internationally
secondary and primary schools for its perfo
units in sizes from 8 to 30 feet in diameter

Moons of the Solar System Scaled to Earth's Moon



Global Positioning System

Constellation of 24 Satellites in Low Orbit

[GPS math on whiteboard]

r-one Centralized Positioning System


20

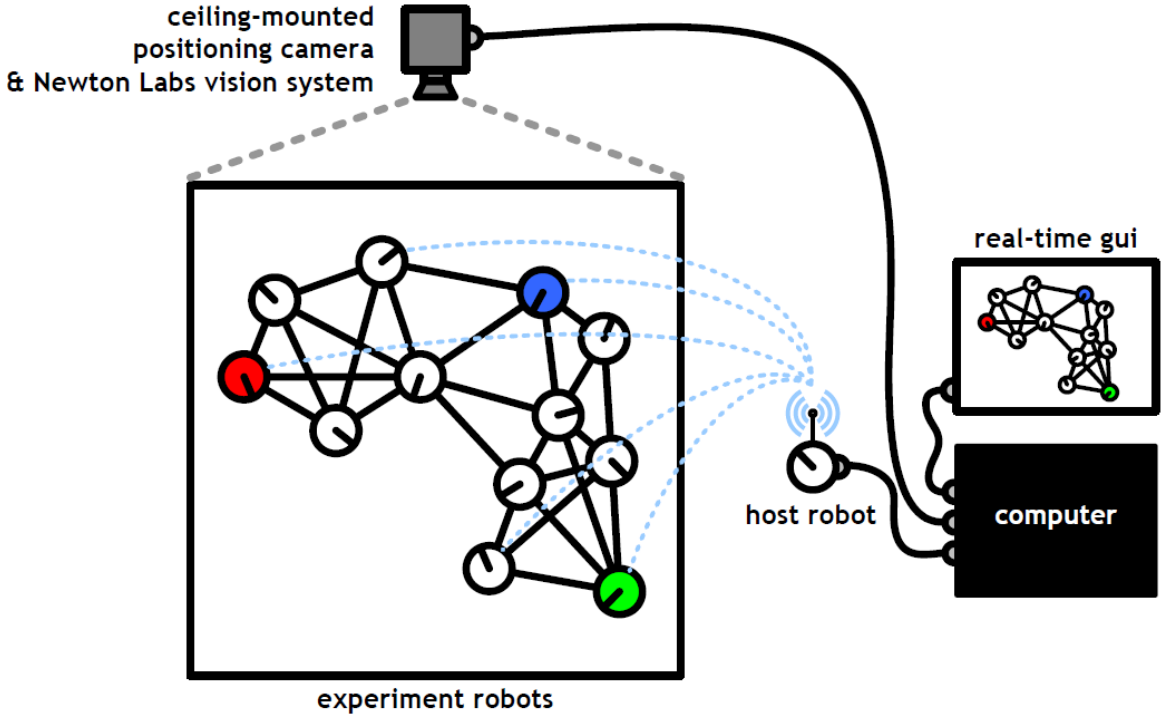
Server Design Sketch

Host robot communicates to robots over radio

- User interface for data collection, debugging, and command and control

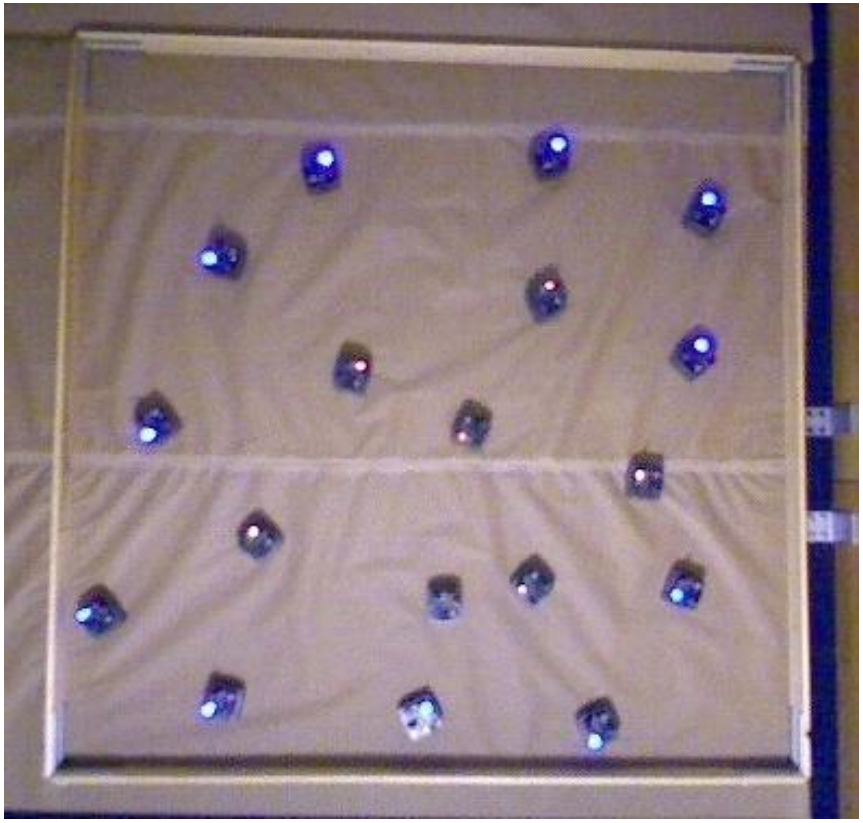
IR LEDs for global localization

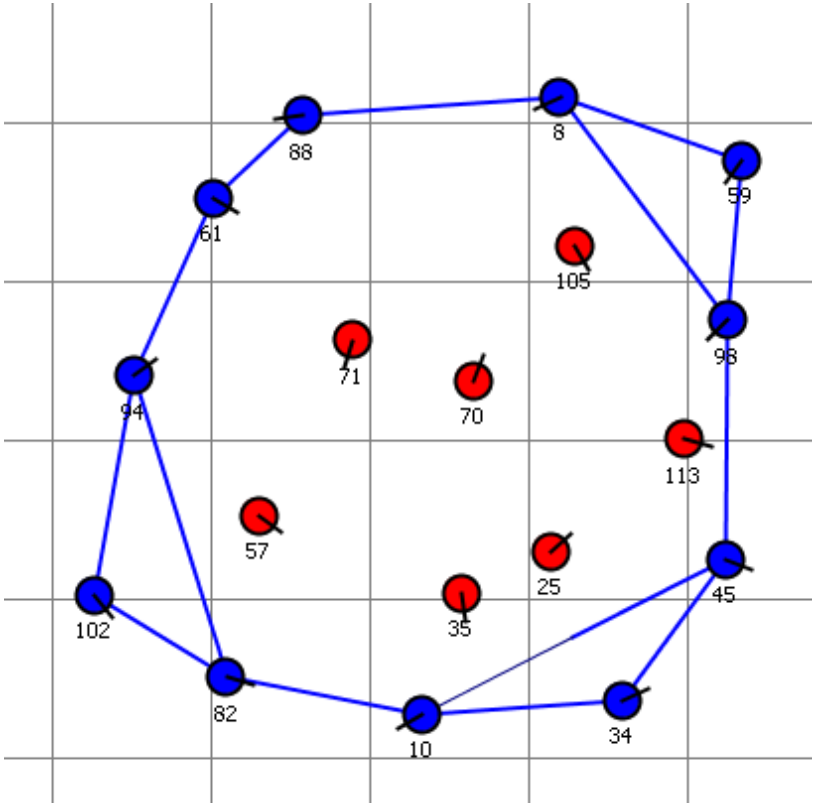
- Each robot blinks its ID for unique identification



Camera Localization

Previous system had an error of about 15mm when camera mounted directly overhead on 5.5 m ceiling.





Problem Sets

PS08: Waypoint Navigation

- It's out.
- It's fun.
- It's due on Tuesday, 11/13/2012

DC06: Tic-Tac-Toe, also on Tuesday 11/13/2012

Longitude and telescope party, Tuesday 11/20/2012