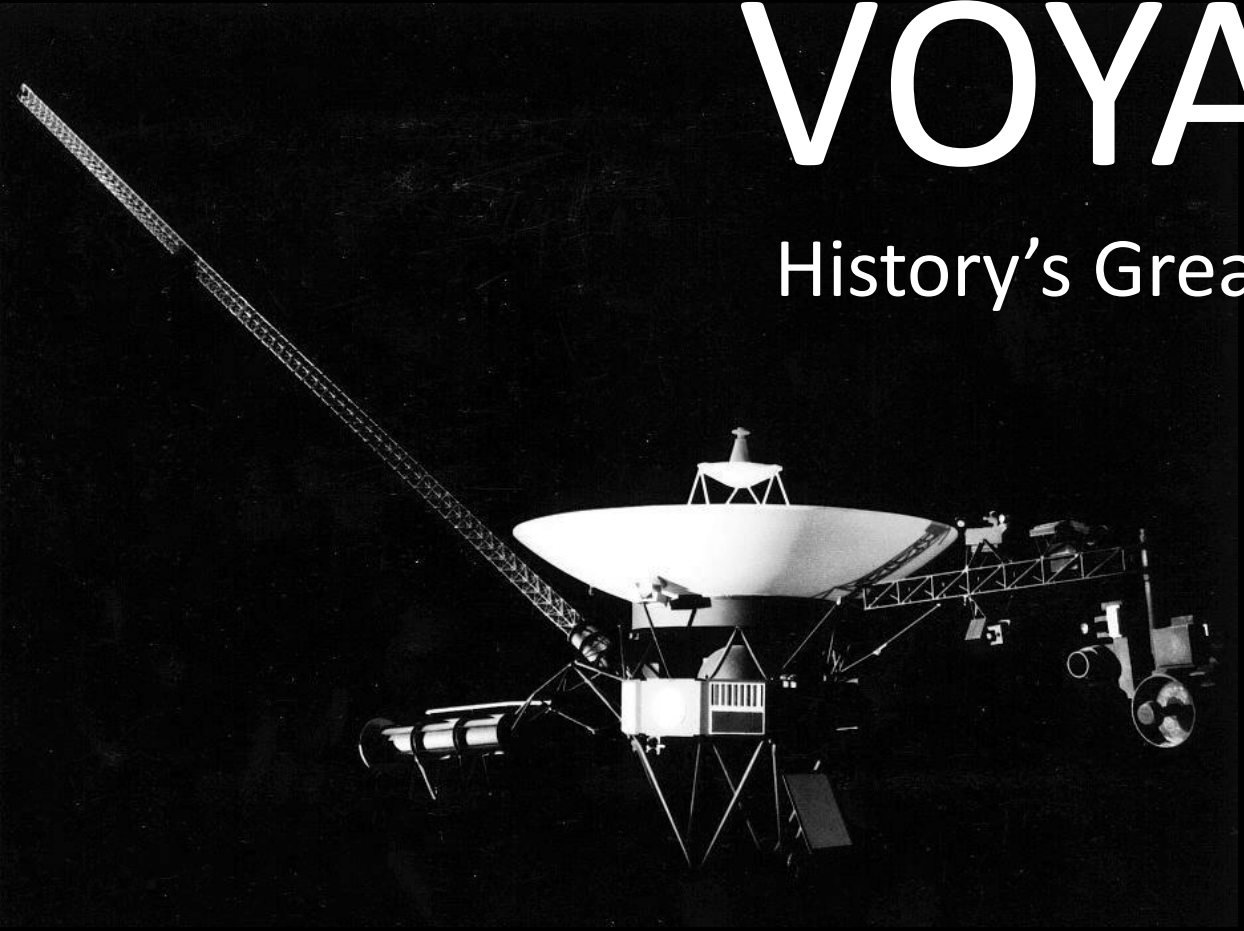
VOYAGER

History's Greatest Explorers



Suzanne Dodd
Jet Propulsion Laboratory
California Institute of Technology
March 1, 2017

Titan III E/Centaur Launch Vehicle

Voyager 2 August 20, 1977
Voyager 1 September 5, 1977

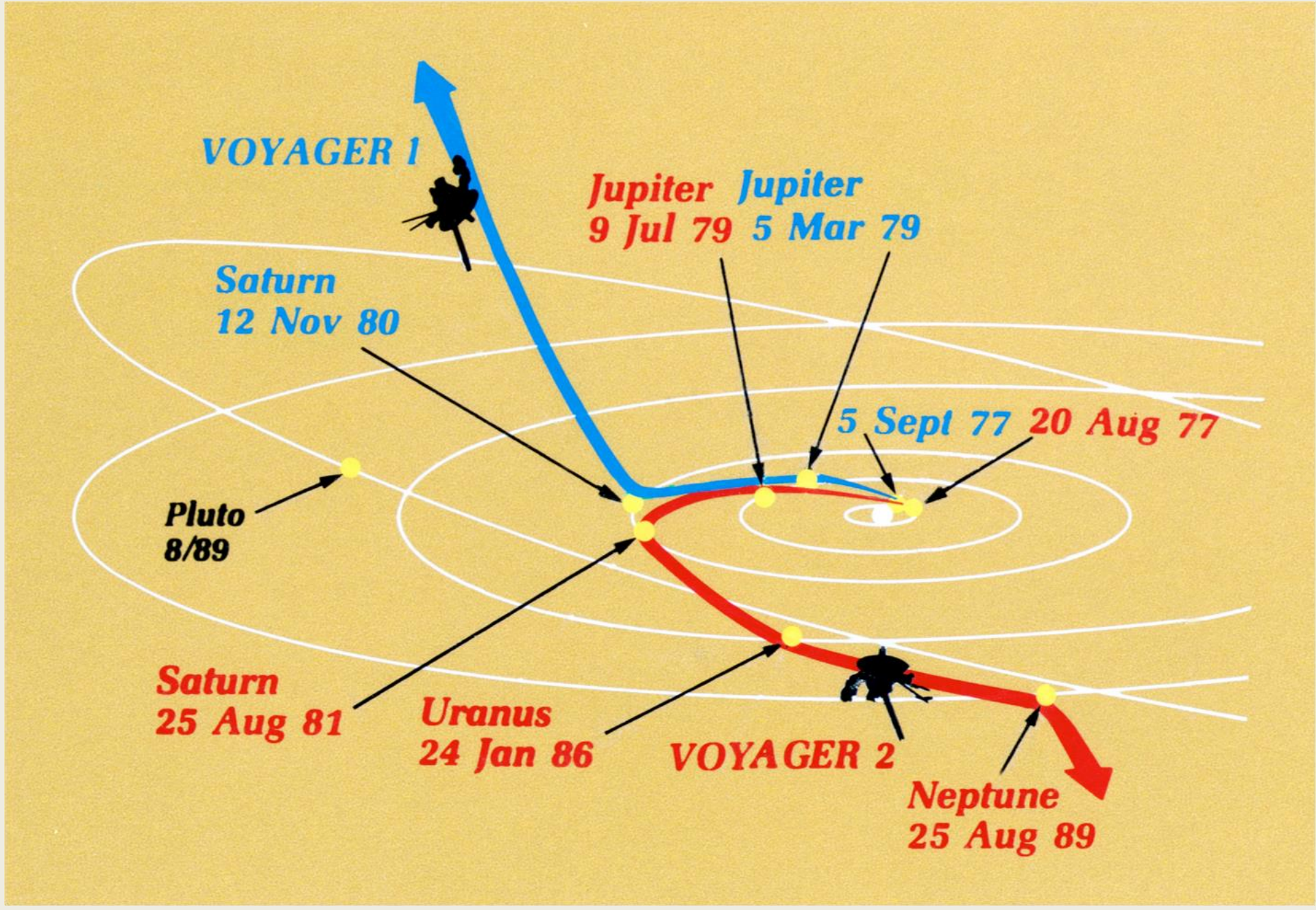
Also "launched" in 1977:

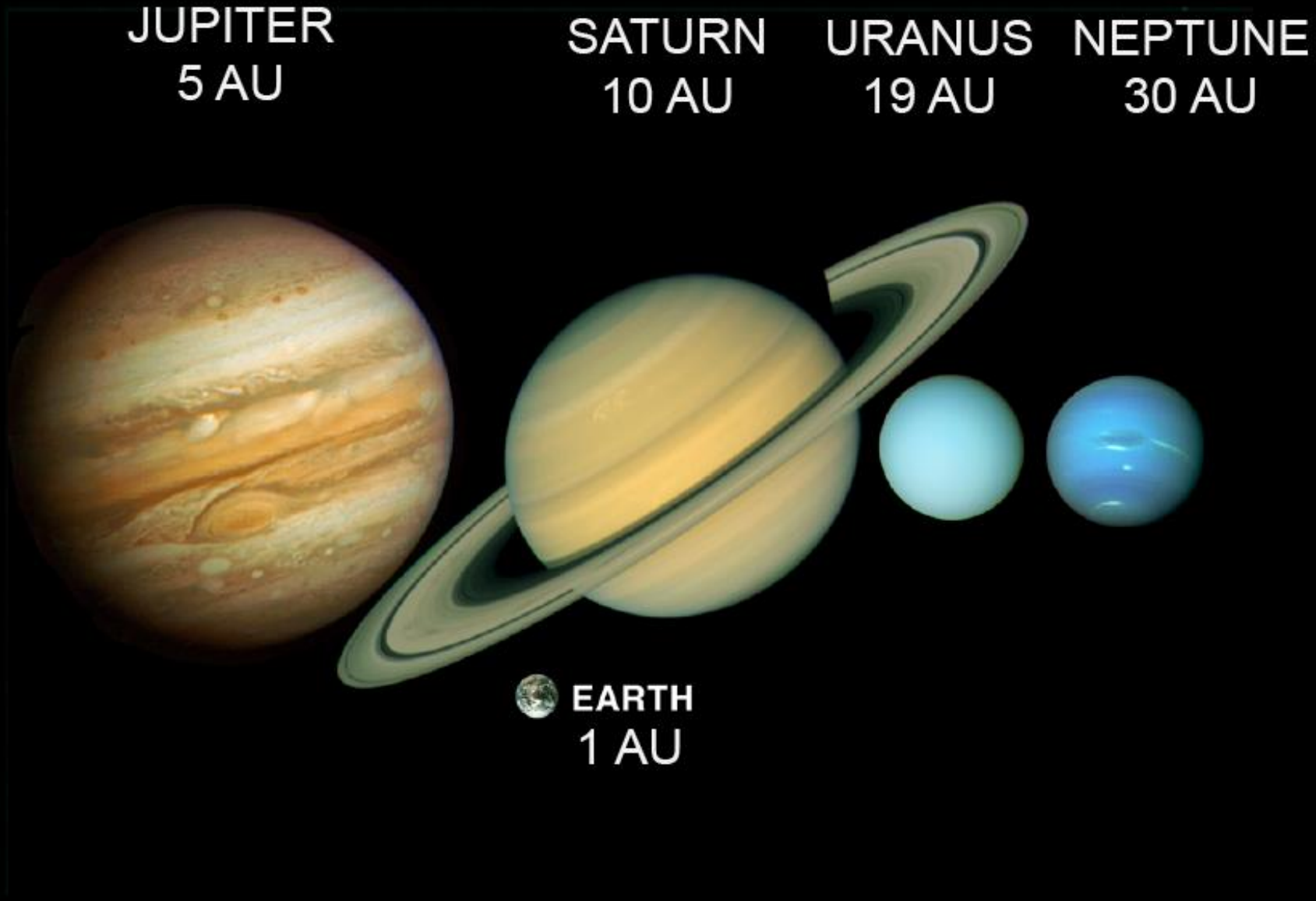
- **Apple II computer**
- **original Star Wars movie**
- **#1 song – "*How Deep is your Love*" by the BeeGees**

Voyager

Voyager 1 and Voyager 2 have 69.63 kilobytes of memory each.
For comparison, an iPhone 5 with 16 gigabytes of memory has about 240,000 times the memory of a Voyager spacecraft.

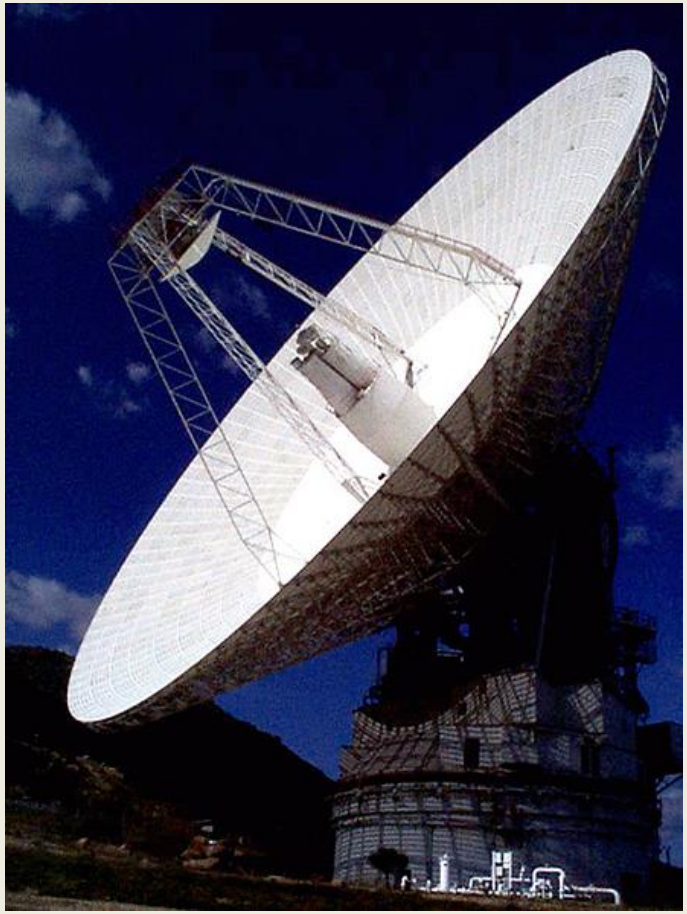
Voyager


VOYAGER 1
Jupiter
9 Jul 79
Jupiter
5 Mar 79
Saturn
12 Nov 80
5 Sept 77
20 Aug 77
Pluto
8/89
Saturn
25 Aug 81
Uranus
24 Jan 86
VOYAGER 2
Neptune
25 Aug 89

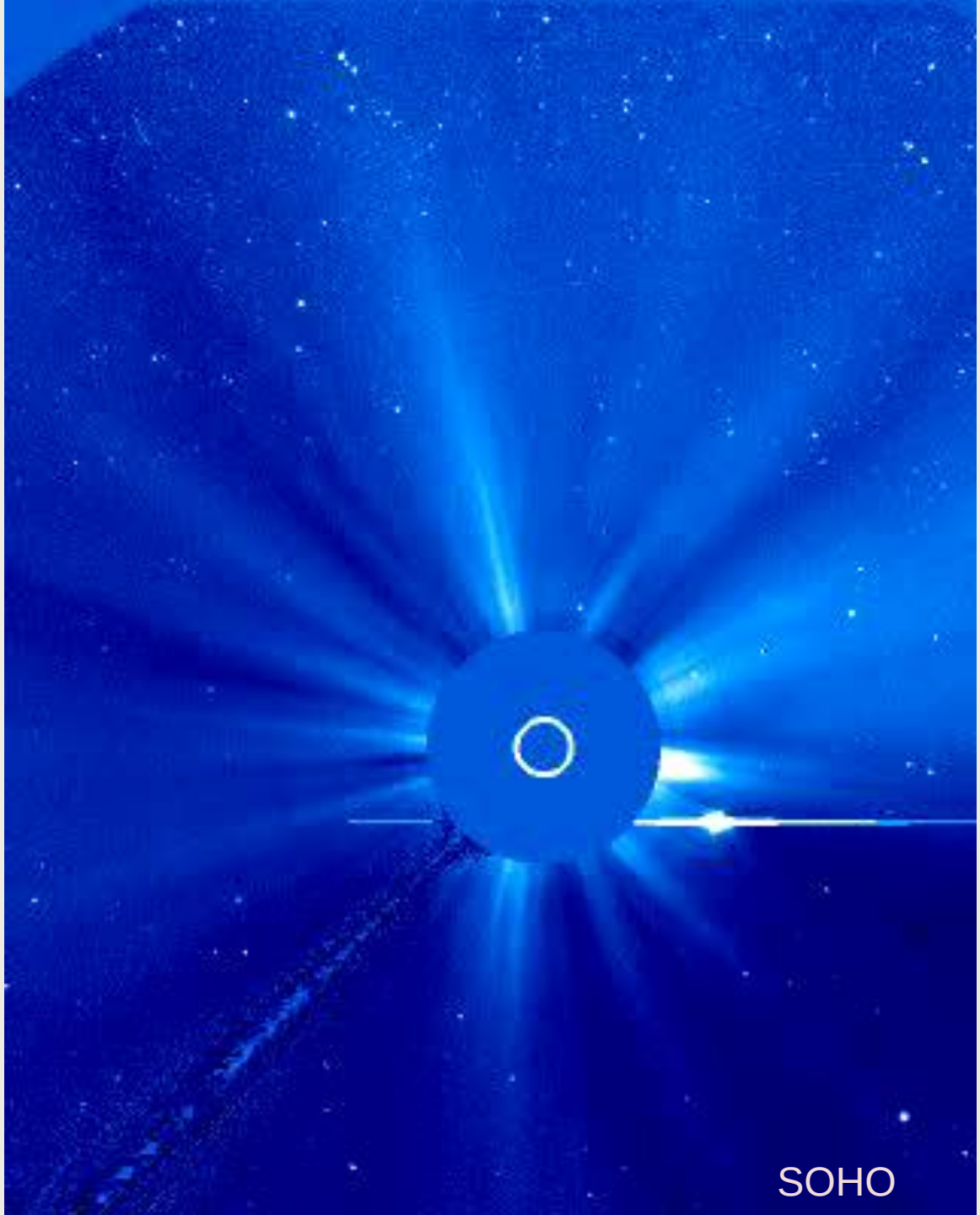


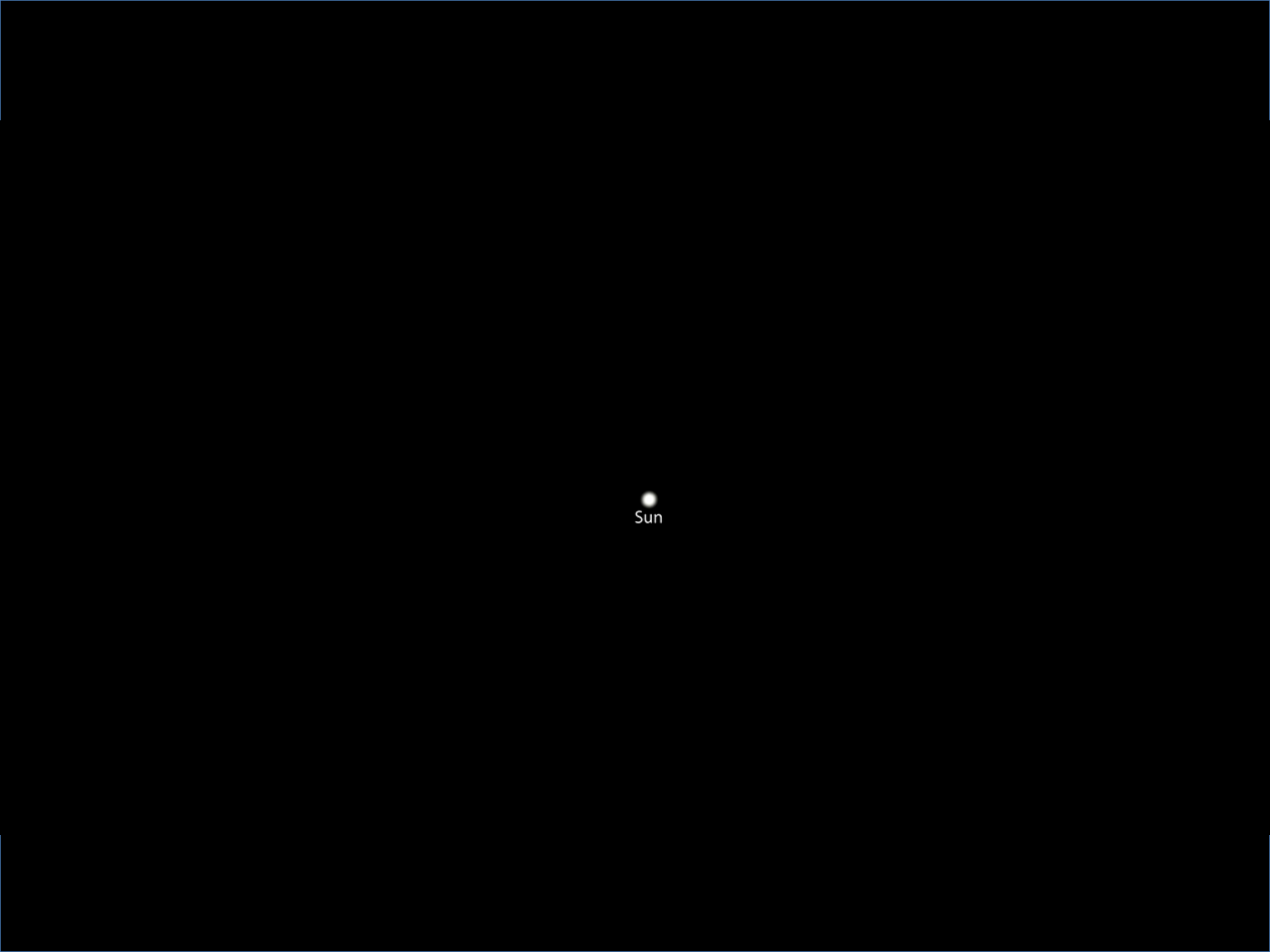
1 AU = 150 million km (93 million miles)

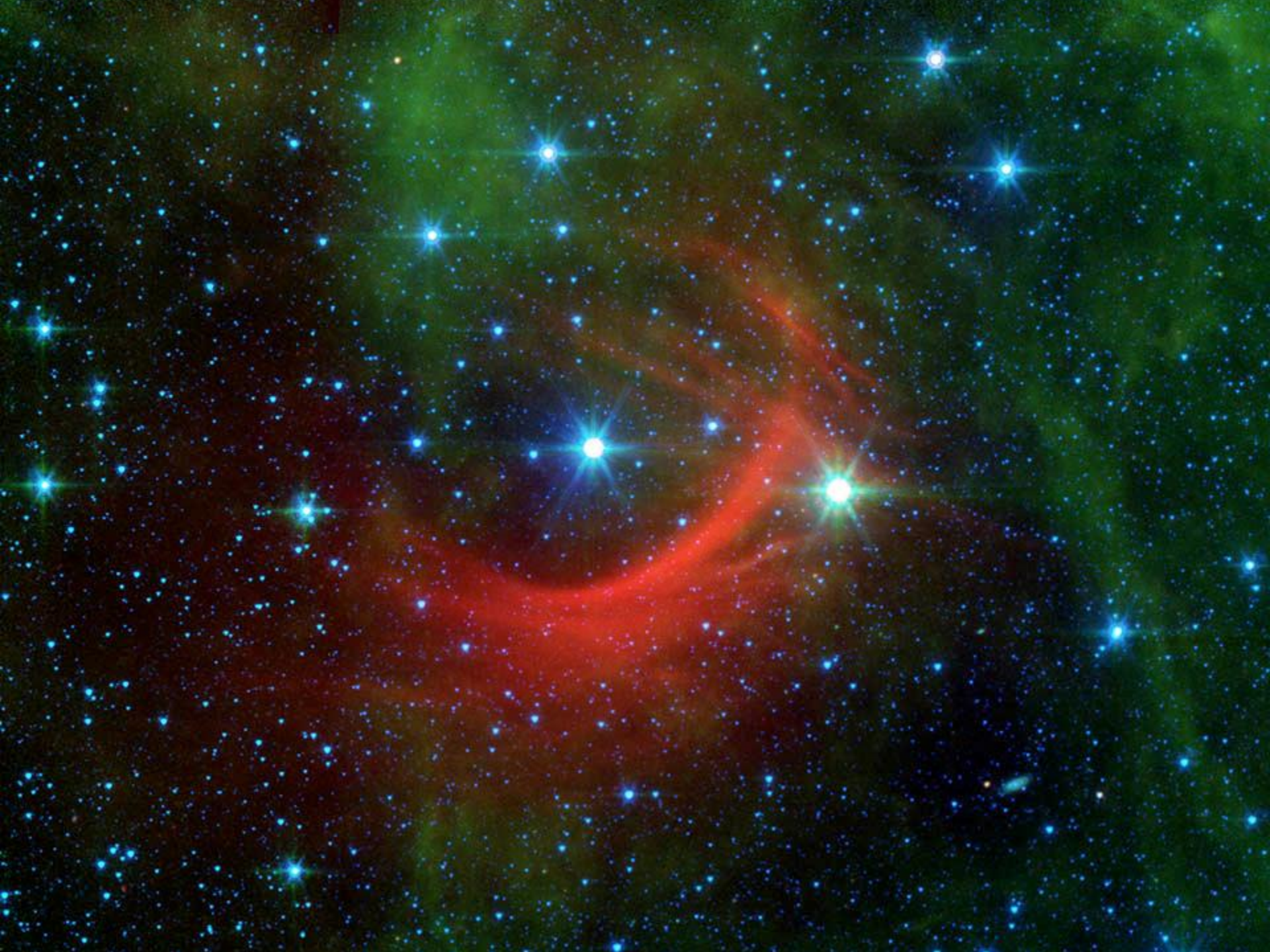
Voyager



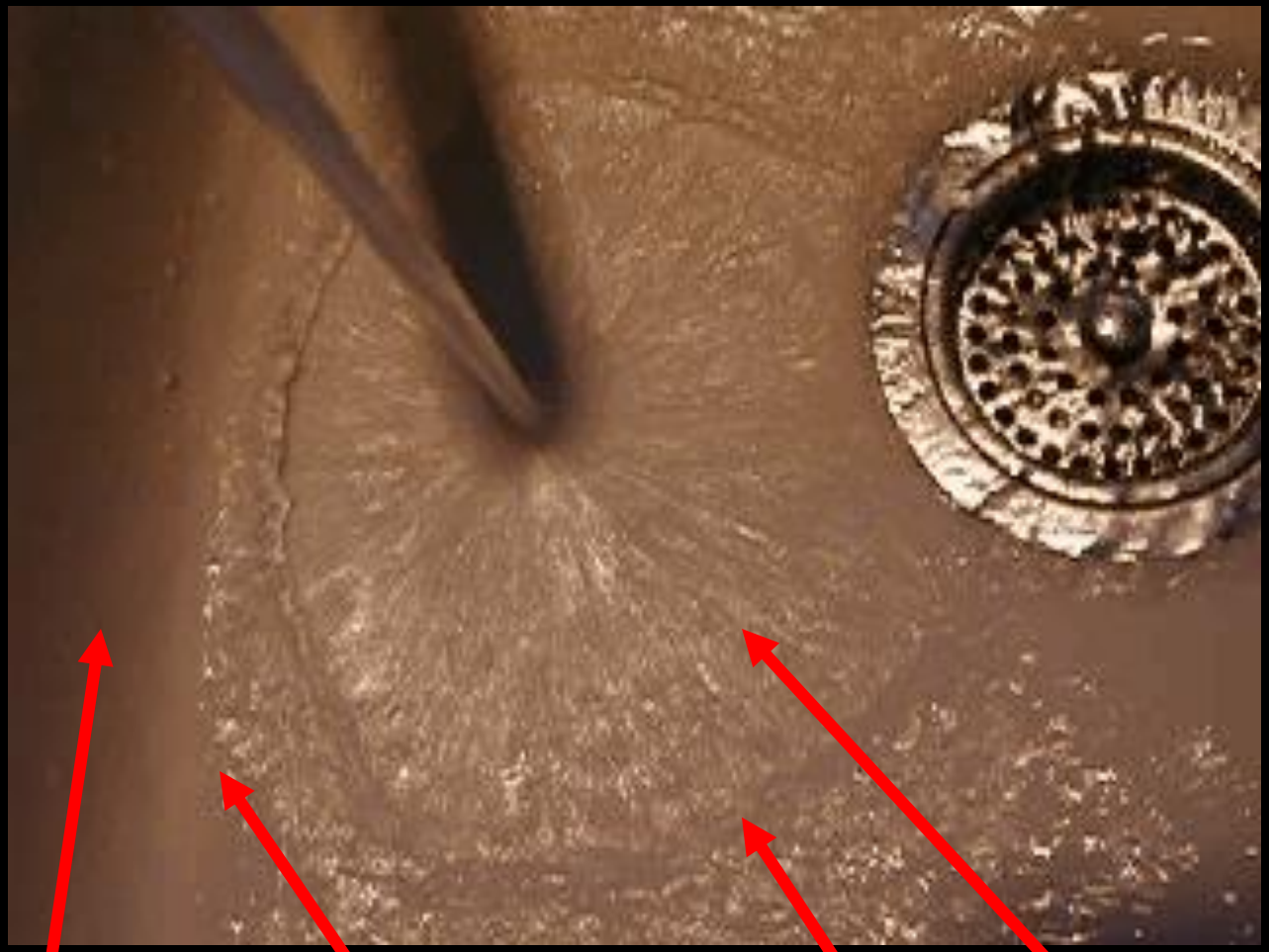
- Voyager relies on the Deep Space Network to return science data
- Voyager data rate is 160 bps
- Roundtrip light time:
  - Voyager 1 38h 14m 26s
  - Voyager 2 31h 39m 50s
- Voyager distance:
  - Voyager 1 20.6B km
  - Voyager 2 17.0B km

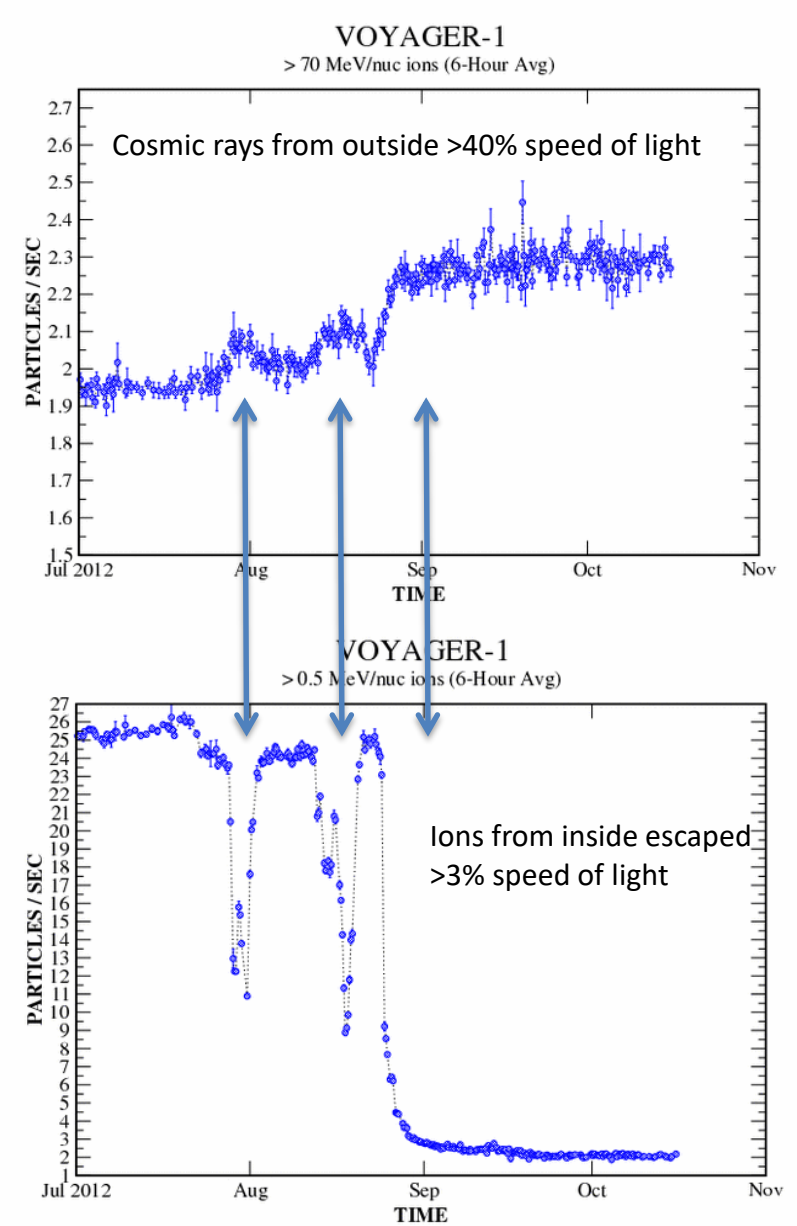

SOHO


Sun



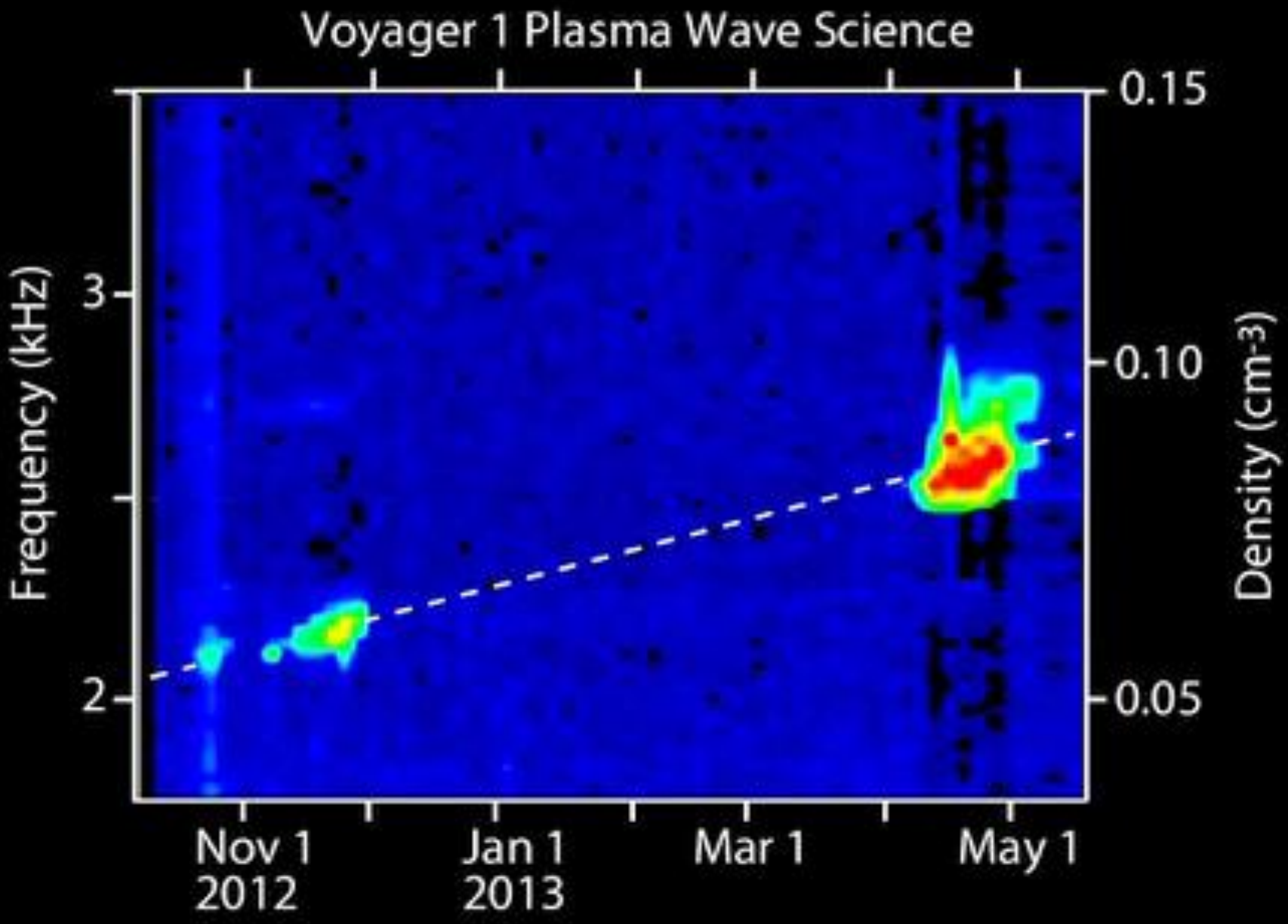
The Heliosphere in a Kitchen Sink

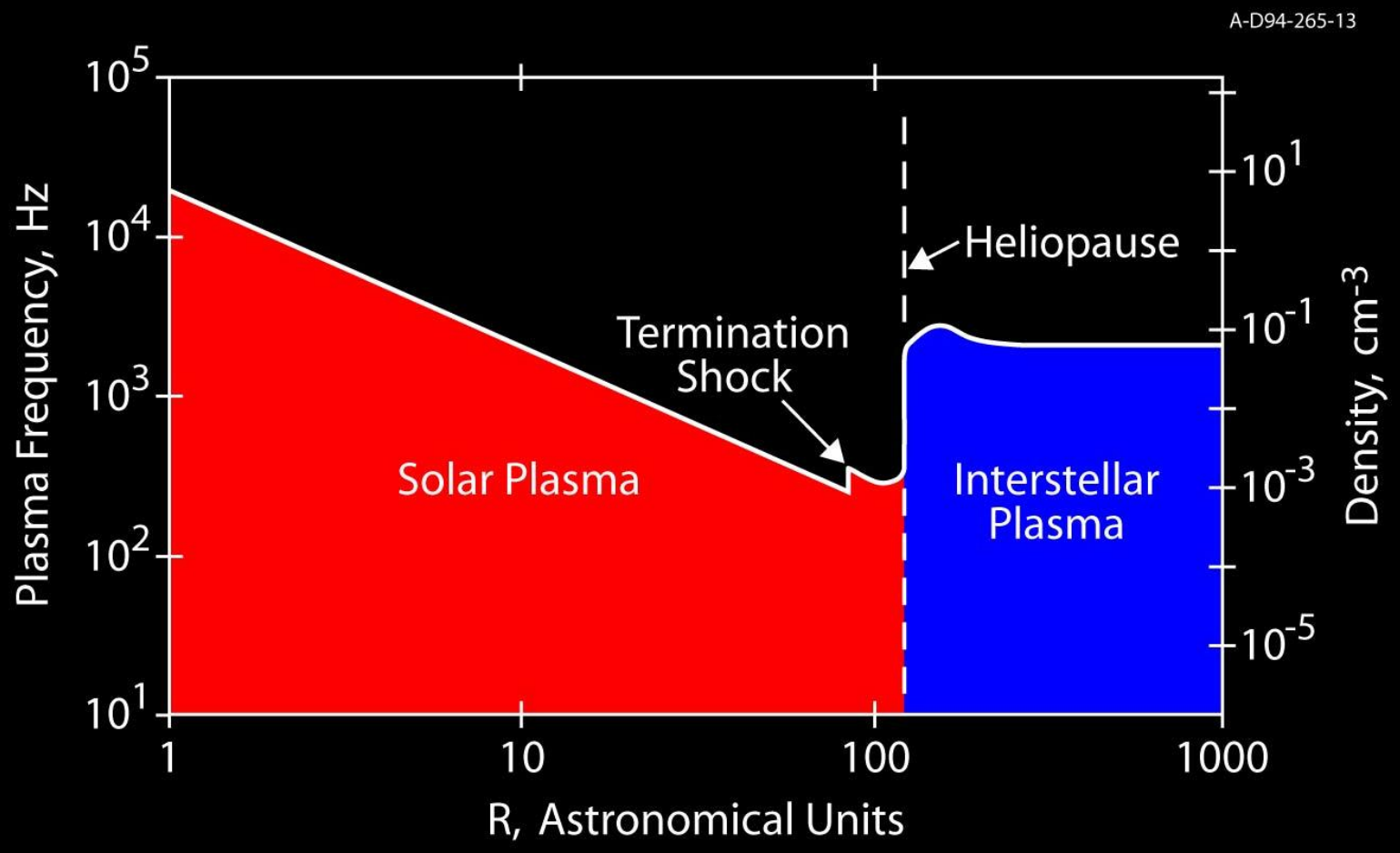




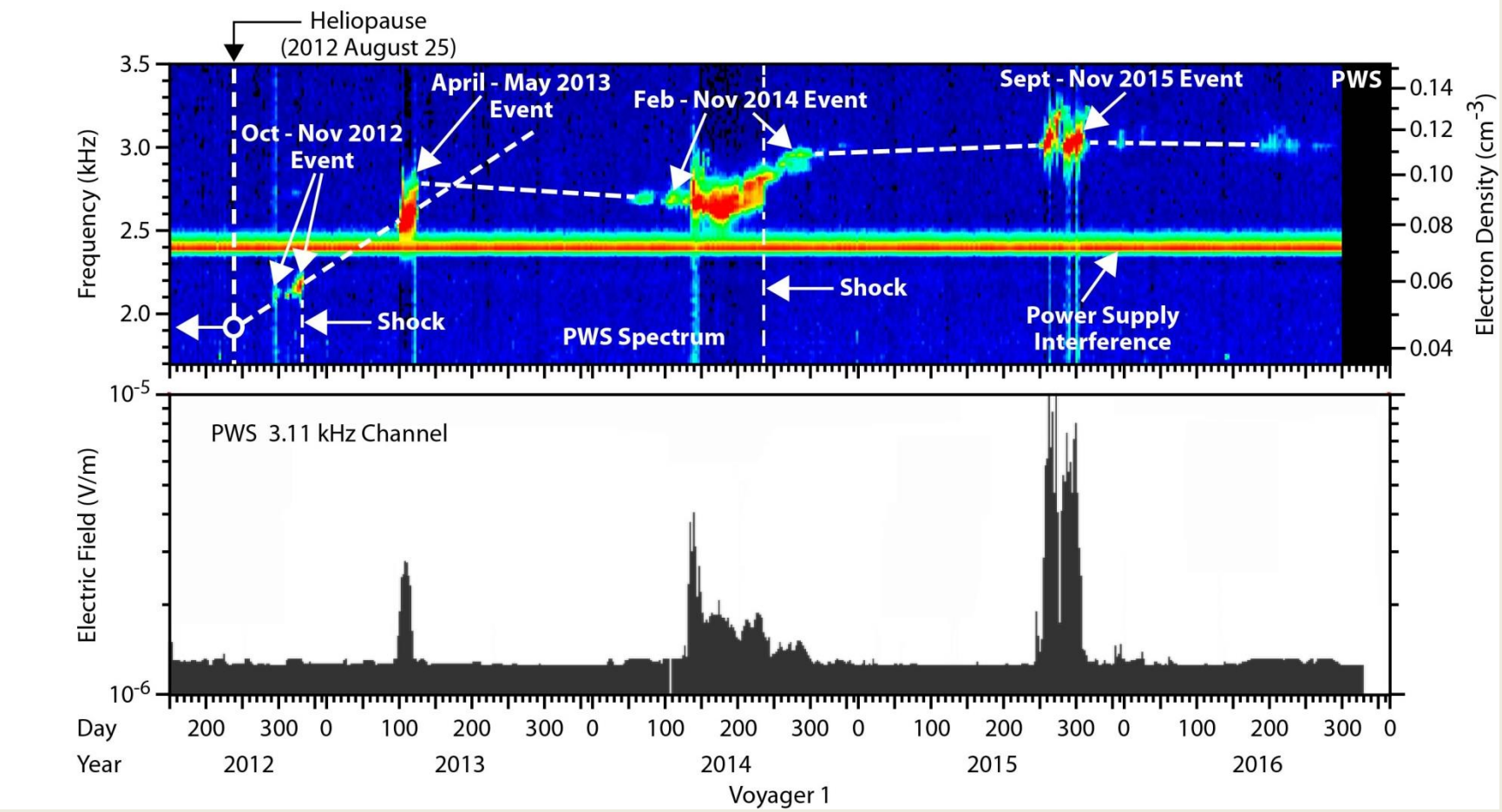
In summer 2012, cosmic rays from outside the heliosphere increased at the same time as ions from inside escaped.

August 25, 2012, ions from inside disappeared. This was the first sign that Voyager 1 was near the edge of interstellar space.


Voyager 1 Plasma Wave Science
Frequency (kHz)
3
2
0.15
0.10
0.05
Density (cm-3)
Nov 1
2012
Jan 1
2013
Mar 1
May 1

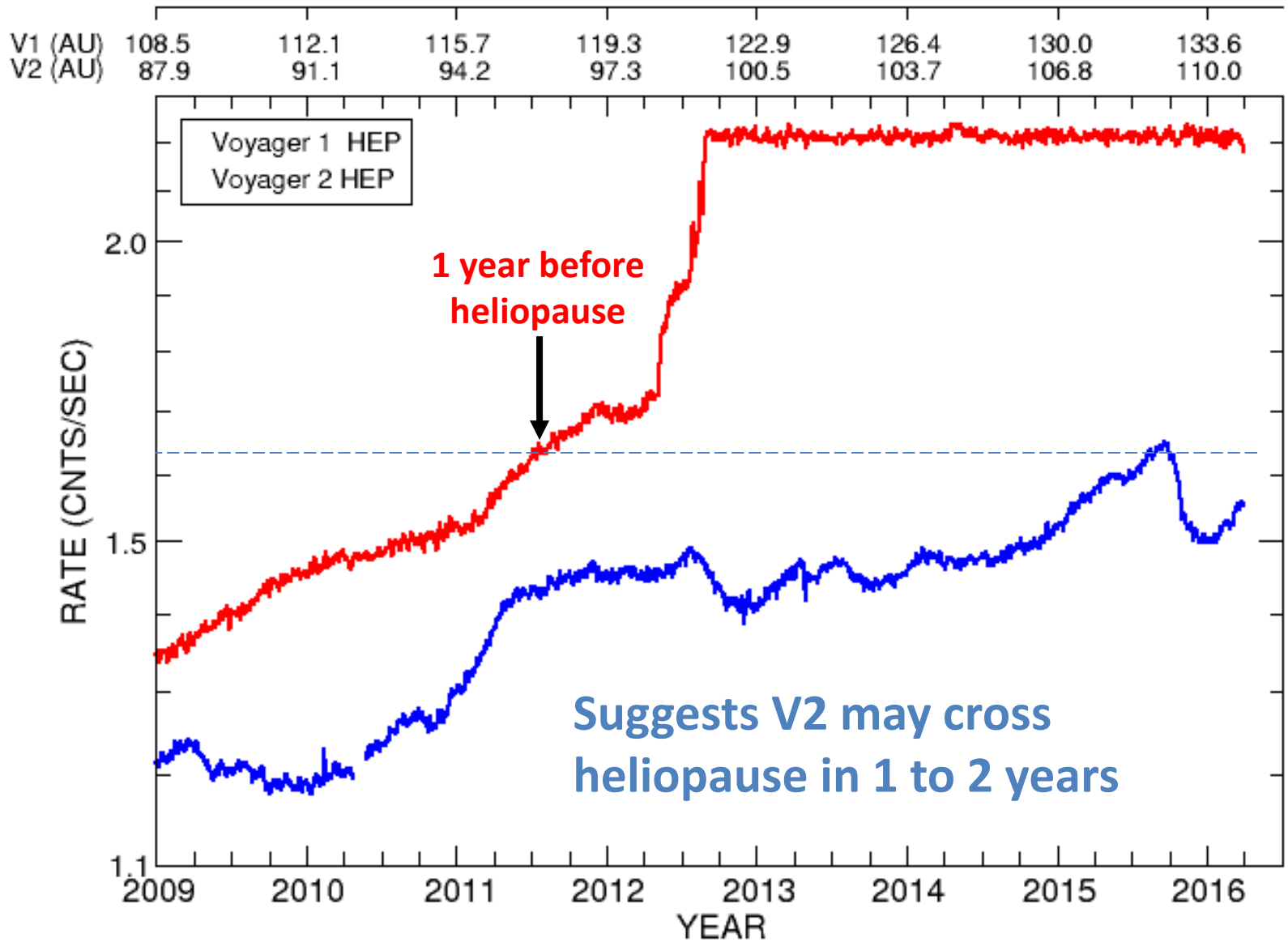

A-D94-265-13
Plasma Frequency, Hz
10^5
10^4
10^3
10^2
10^1
Density, cm^{-3}
10^1
10^{-1}
10^{-3}
10^{-5}
Heliopause
Termination Shock
Solar Plasma
Interstellar Plasma
1
10
100
1000
R, Astronomical Units

Overview of Electron Plasma Oscillations In Interstellar Space (4 Main Events)

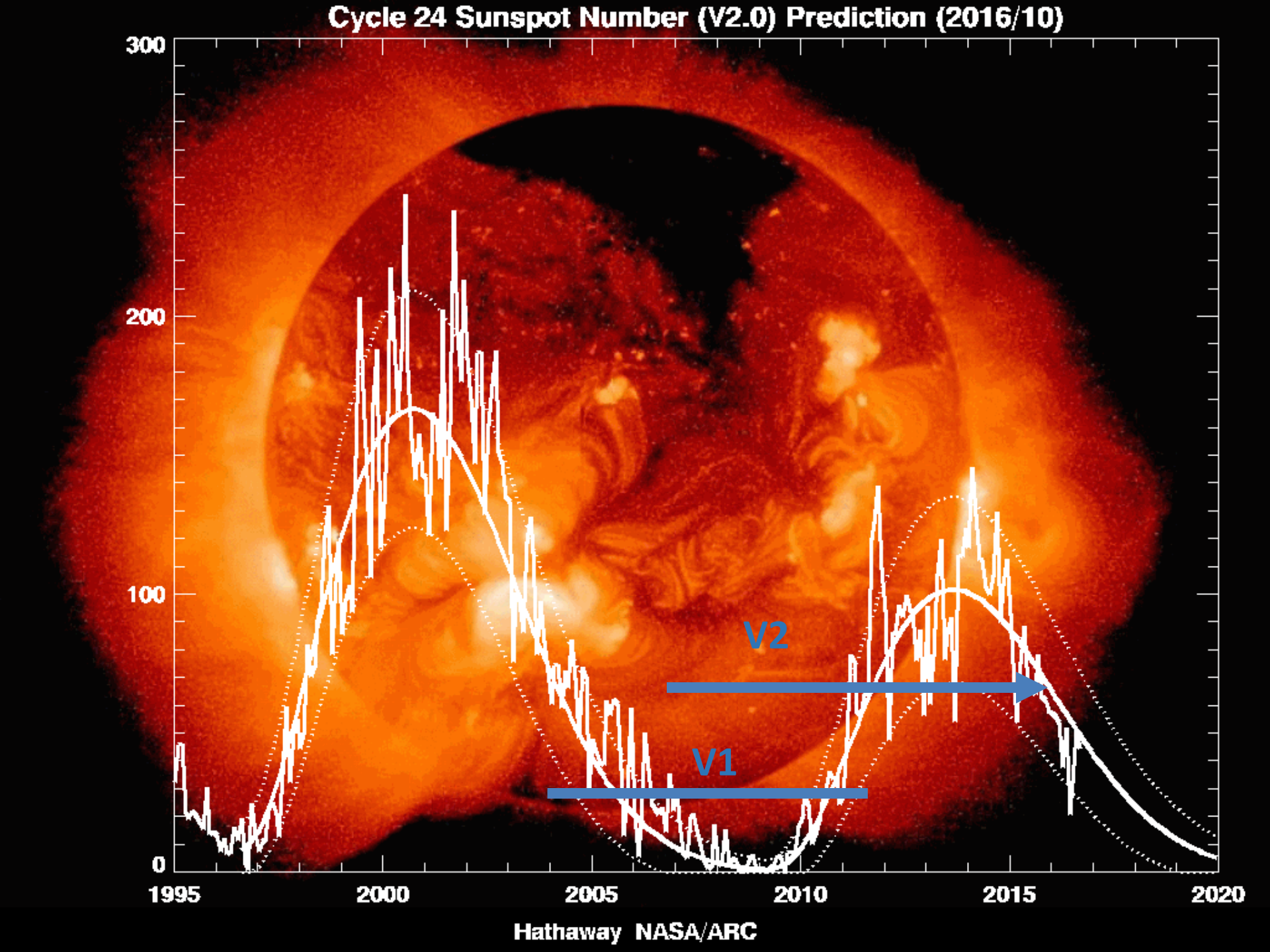


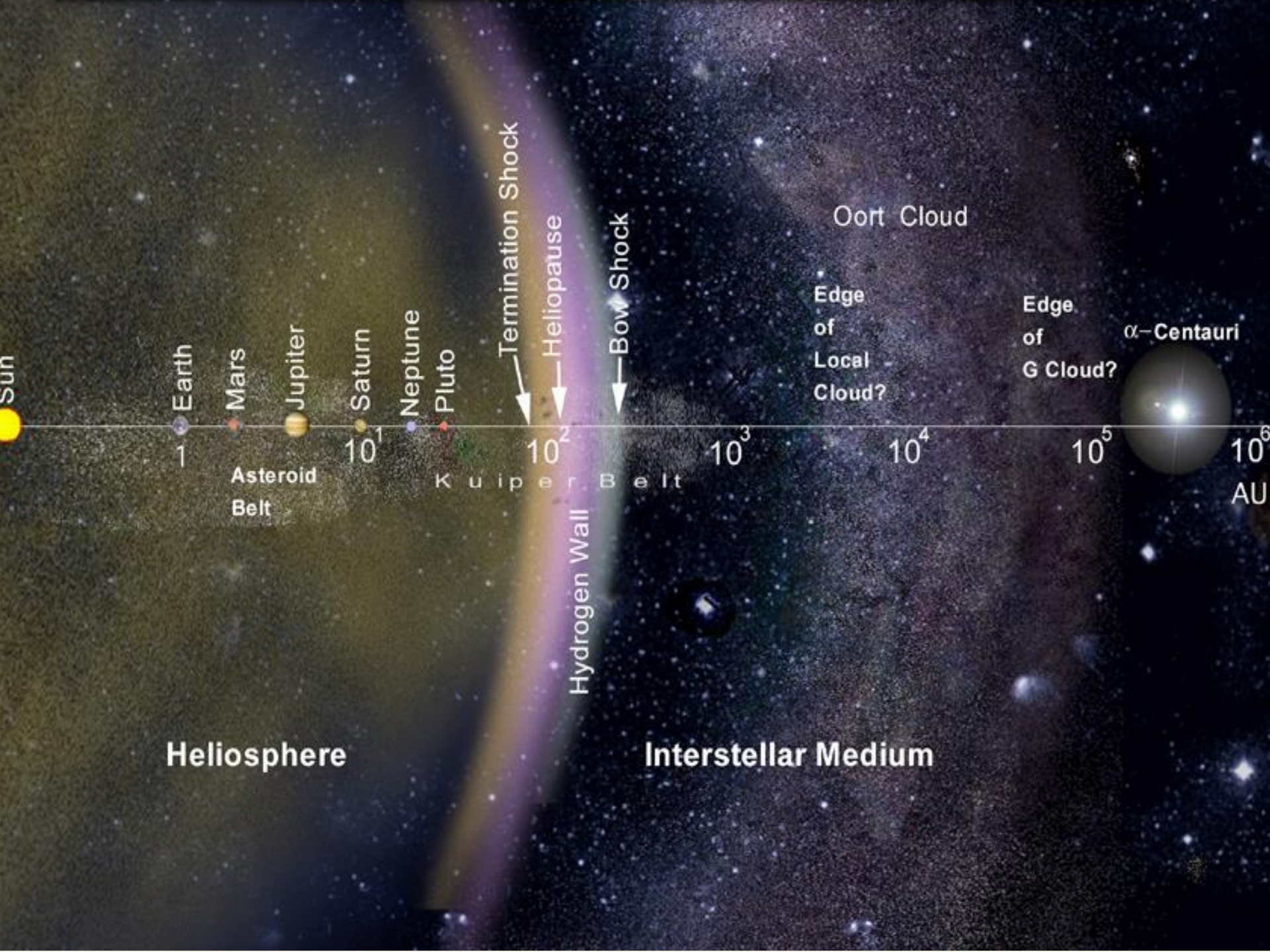
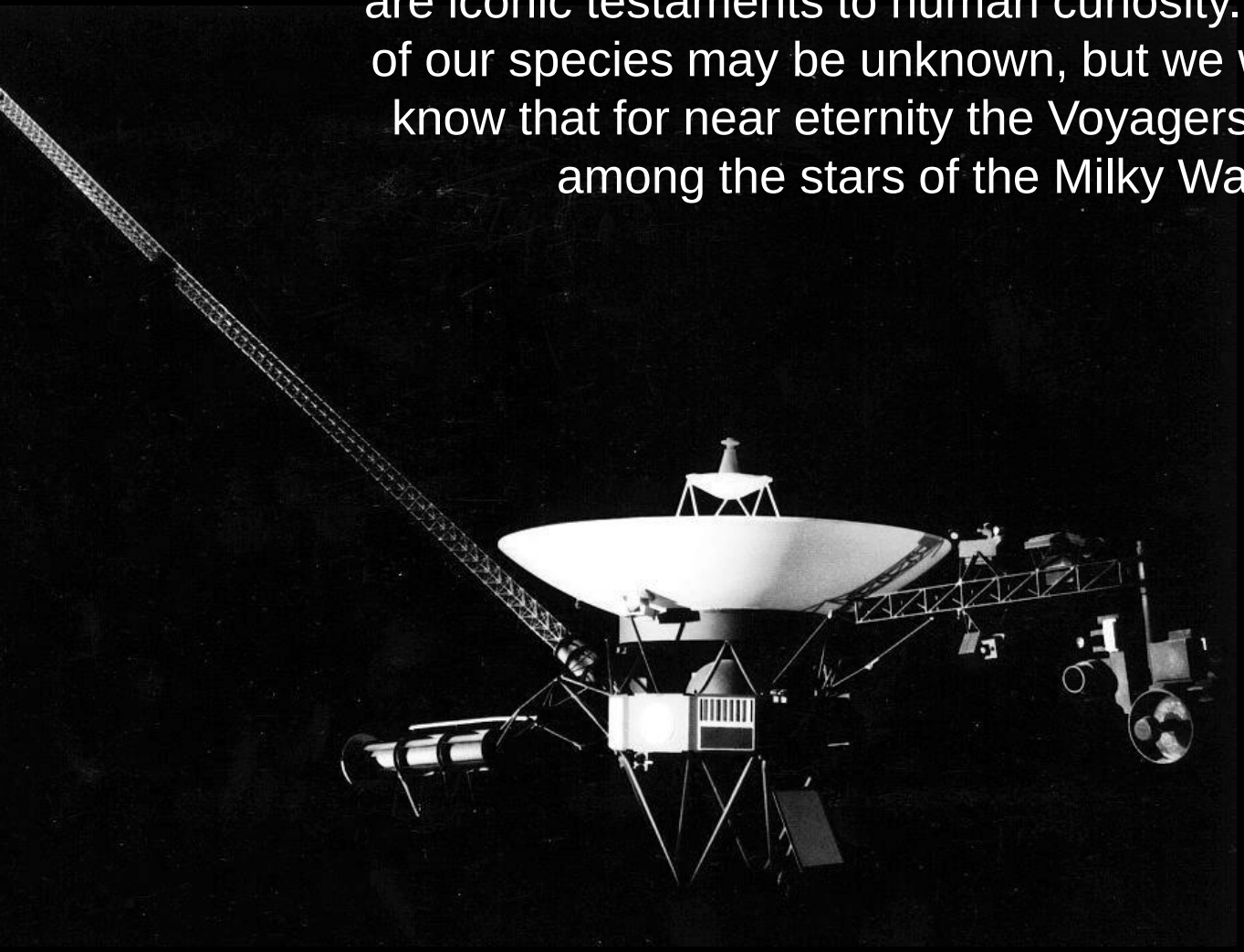
Gurnett & Kurth 2016

Cosmic Rays from Milky Way Galaxy



Fri Apr 1 17:00:04 2016


Cycle 24 Sunspot Number (V2.0) Prediction (2016/10)
300
200
100
0
1995
2000
2005
2010
2015
2020
V2
V1
Hathaway NASA/ARC


Sun
Earth
Mars
Jupiter
Saturn
Neptune
Pluto
Termination Shock
Heliopause
Bow Shock
Oort Cloud
Edge of Local Cloud?
Edge of G Cloud?
α−Centauri
1
10^1
10^2
10^3
10^4
10^5
10^6
AU
Asteroid Belt
Kuiper Belt
Hydrogen Wall
Heliosphere
Interstellar Medium

Whatever their future discoveries, the twin Voyagers are iconic testaments to human curiosity. The future of our species may be unknown, but we will always know that for near eternity the Voyagers will glide among the stars of the Milky Way.