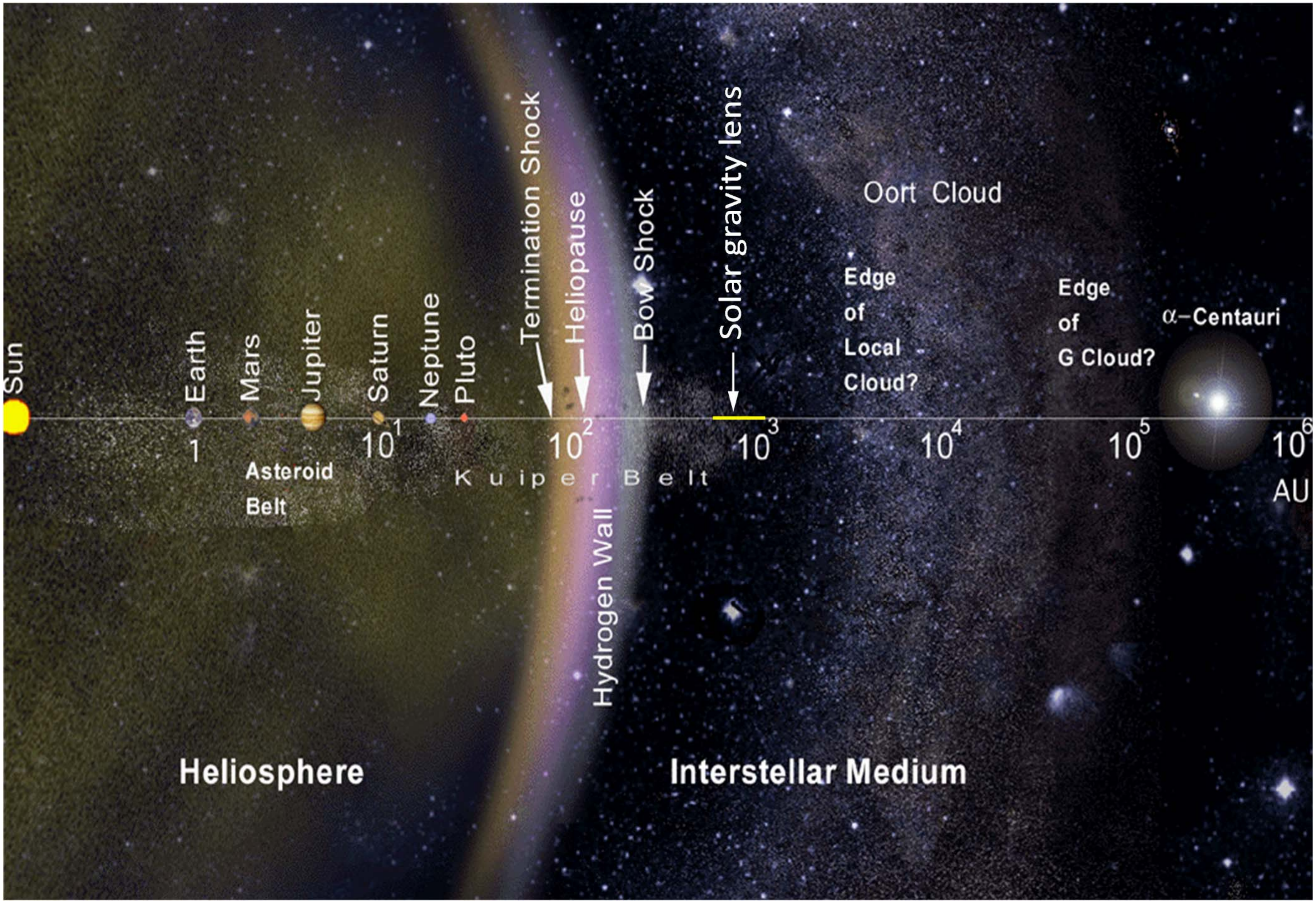

Sun
Earth
Mars
Jupiter
Saturn
Neptune
Pluto
Termination Shock
Heliopause
Bow Shock
Solar gravity lens
Oort Cloud
Edge of Local Cloud?
Edge of G Cloud?
α−Centauri
1
10^1
10^2
10^3
10^4
10^5
10^6
AU
Asteroid Belt
Kuiper Belt
Hydrogen Wall
Heliosphere
Interstellar Medium

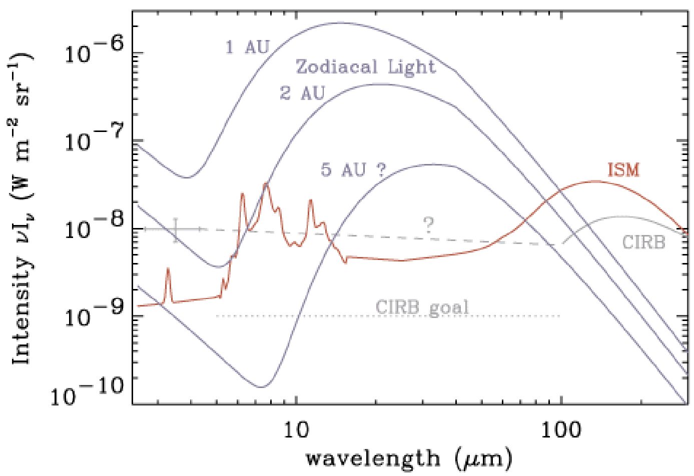
Gravitational Lenses of the Sun

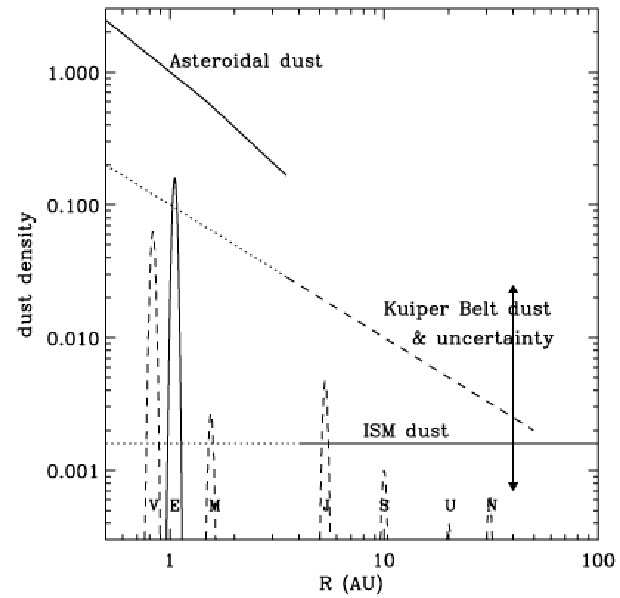
- The inner Solar Gravitational Lens: 25 AU outwards
  - Most of the solar mass is concentrated in its core (radius is 0.25 Rsun). Over 95% of the solar mass is concentrated in the solar core, which is inaccessible to photons; however, it can be reached by extrasolar neutrinos.
  - Foci is 16 times shorter than for photons ~ 25 AU
  - Should there be a well-known neutrino source, such as AGNs, supernovae, etc., this may be of interest to a wider scientific community

- The outer Gravitational Lens: 550 AU outwards
  - Challenging, but exciting possibilities relying on Gain of 110dB (at 1 um)
  - Even a confirmation would be great
  - Pre-selected, well-defined in advance specific targets and require navigation to place the spacecraft at the foci corresponding to those targets (exoplanets);
  - Choose to observe "random" parts of the sky to great depth. Potential targets may include accretion disks around black holes, compact stars or the cores of AGNs, small-scale structure, deep fields...

Solar system, outer regions

- Solar system studies:
  - Optical comm/astrometric camera: Near Earth asteroids, orbits of outer bodies,
  - IR camera: Zodiacal background, outer bodies
  - Flybys, IR, optical camera: Sedna, objects from the extended scattered disc objects (E-SDO) with semi-major axis extending well beyond 100 AU
  - Structure of the Zodiacal cloud (Sun, planets, asteroids, comets, and KBO)
  - Distribution of small KBOs and dust (formation of the solar system)
  - Organic matter in the outer solar system & ISM (origin, nature, and distribution)





Precision tests of gravity

- Fundamental physics:

  Many tests of GR and modern theories of gravity, especially those proposed to explain dark energy, are possible

  – Test the gravitational inverse-square law on extremely large heliocentric distances (beyond 200 AU), would place stringent limits on the presence of dark matter in the solar system and in its local environment.
  – Test for the presence of a new physical interaction by measuring the Eddington parameter γ with a precision better than the current Cassini result of 2.3×10^{-5}. Improvements of up to 2 - 4 orders of magnitude are possible.
  – Test of the Local position invariance with atomic clocks on board.
  – Test of the spatial & temporal dependencies in the gravitational and fine structure constants.
  – Test of the Equivalence Principle with spacecraft and the Sun as two bodies freely falling towards the Galaxy – a unique test, never attempted before
  – Test of one-way speed of light (precision ranging and stable clocks on board).
  – Gravity waves? A pair of interstellar probes may be used to search for and to study gravitational waves from a variety of sources.

Science towards and from the ISM

- At large heliocentric distances
  - Exoplanets (as we move out of the zodiacal background)
  - Detection of low energy cosmic rays
  - Nomadic planets discovered via microlensing
- Parallax science: by measuring parallaxes to many millions of stars
  - Parallax measurements to 1uas is possible
  - Would provide direct distances to stars inside and outside our galaxy
  - Distances to a number of Population II objects (oldest stars in our galaxy)
  - Reducing the uncertainty in the estimated ages of these oldest stars
  - Probe the early formation history of the Milky Way
  - Distance scales, structure and history of Milky Way galaxy
  - Extragalactic distance scale (Cepheids, globular clusters, spiral galaxies, SNe..)