Improving SETI : Search for Extraterrestrial Intelligence.

Don’t ask how to look for others- ask how they look for you!

Had idea in -5, Subo Dong in -1,
Seth Shostak in -10, Latham student??

Some Russians in -20 Years.

IS ANYONE THERE ? Are we all alone? (Be more careful with planet earth)

QUESTION: How many stars within our Galaxy (In whole visible universe…) have planets on which intelligent Life and technological civilization AND which are (were..) trying to communicate with us developed ?

ANSWER: 2.10^{11}. F(Drake). F'

F(D) =f(p). n(lZ). F(Life).F(In-gent) F(survive)

F(p) =0.01	N(LZ)= 0.01	F(L)= 0.01	F(Int)= 0.01	F(S)= 10^{-8}	N.R= 2x10^{-5}
0.5 !	1	1	1	10^{-4}	110^7 !!
0.5	0.1	0.01-0.0001	0.01	0.1-0.001	10^1-10^5

How long will they keep sending messages to us ?

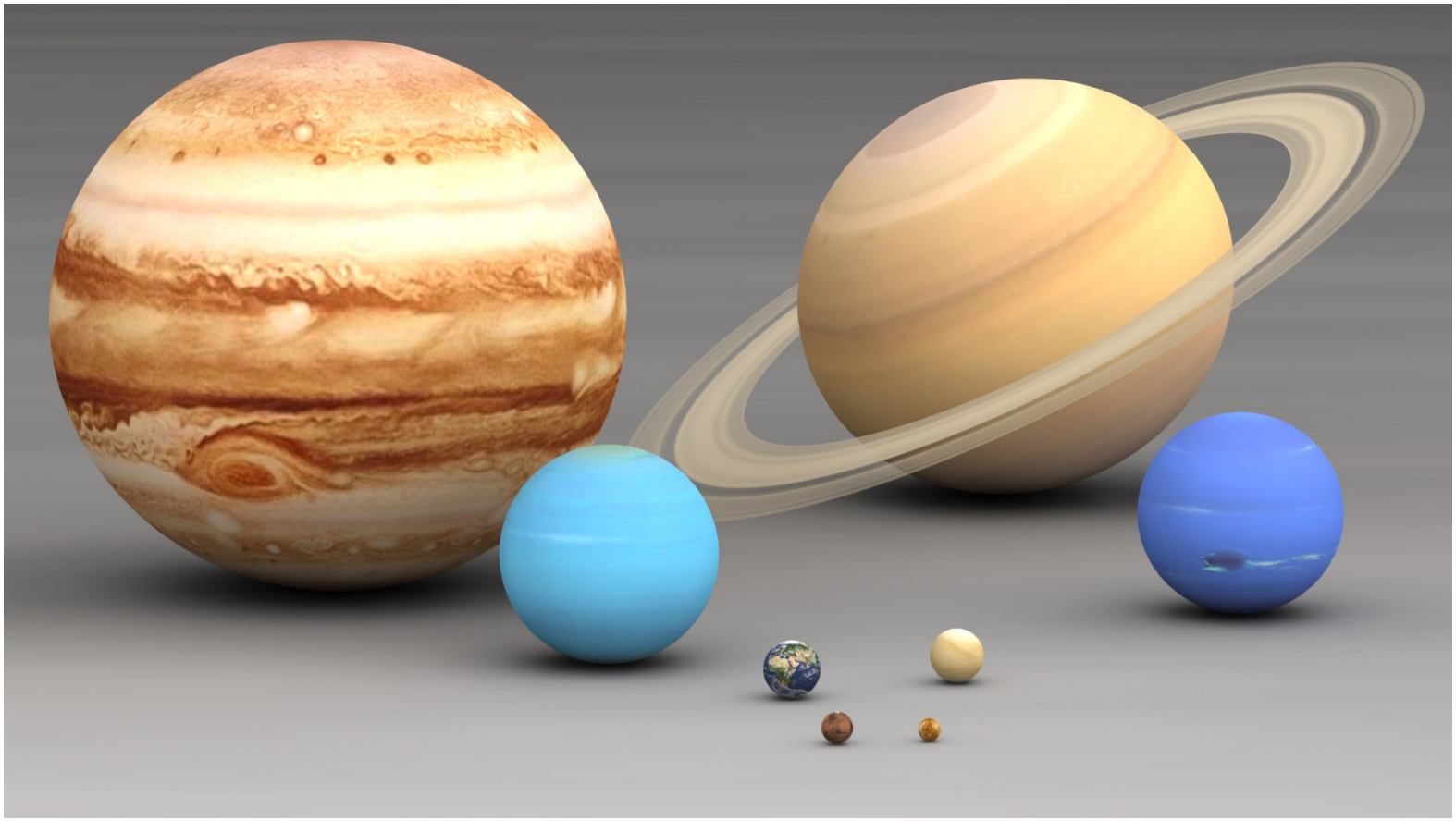
- We (NASA ,Congress, etc.) got tired after ~ 50 years – yet we hope they will keep searching for planets like ours and then sending us messages for MILLIONS OF YEARS

- ONLY then they become relevant the # of effective ETI's is ~ their perseverance

F’ factor: Why would they be sending signals to US ? How long would they keep sending messages?
AND HOW DO WE KNOW THAT IT IS FROM THEM TO US?!

We ARE BEATIFUL!! (see our pictures) BUT we are shy – rather than look head on into the crowd, we show to most stars only our profile by having the ecliptic plane inclined by at 60 degrees relative to the plane of the galaxy

Our Solar system:



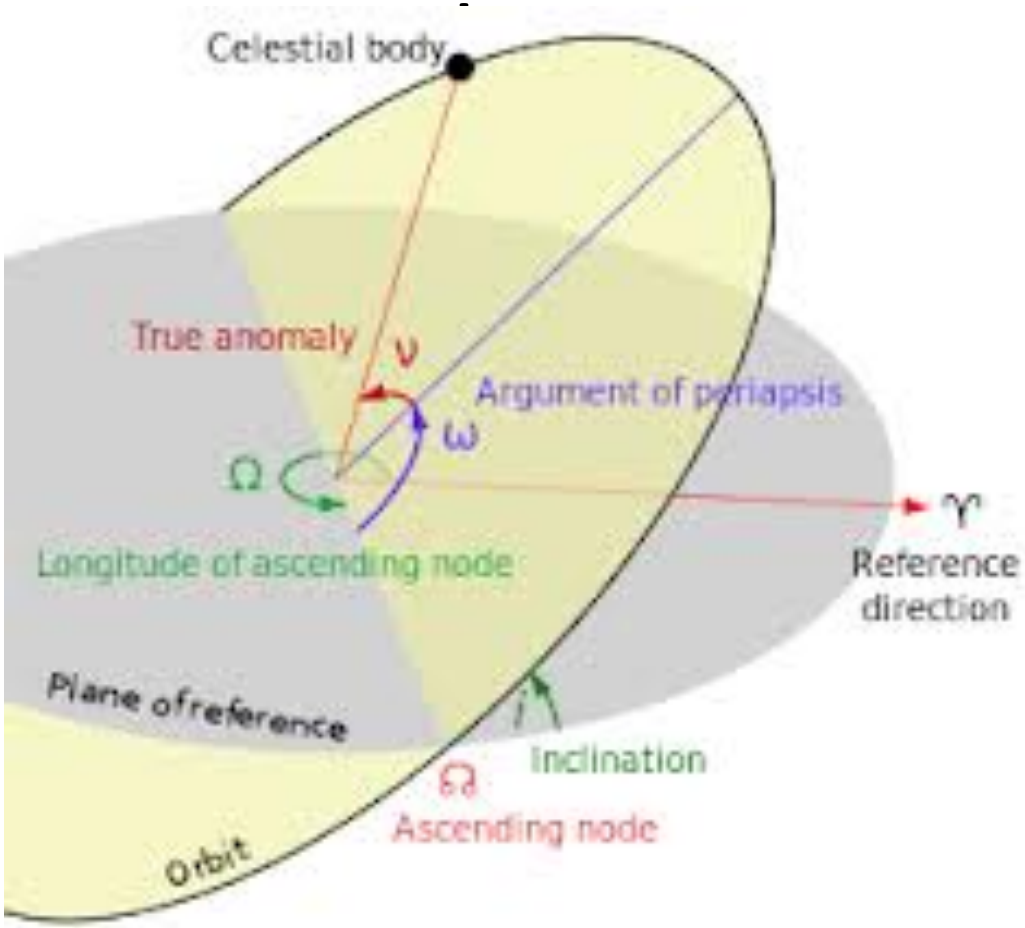
Planets orbits

KEY # 1 : They will send us messages ONLY if they discover and find us encouraging !

- How do they discover planetary systems and us in particular? In new ways we have not dreamt of. But also by using:
- The stars periodic stellar wobbling and Doppler shift of the spectrum v/c ~ 10^{-10}!
- Micro-lensing ,not reproducible, fails for us. S.D.
- Astrometry/ Direct imaging of planets 10^{-9}!
- THE TRANSIT METHOD : SEE VENUS Transiting sun

A transit of Venus as seen from earth

Inclination of ecliptic versus galactic



BY FAR EASIEST FOR SMALL PLANETS DISTANT FROM STAR!

Decreases luminosity by [r(p)/R(*)]^2 (80 ppm for us) ONLY ETIS SITUATED AT +/- \theta= R*/a(p) relative to the ecliptic -1^o can see us this way ONCE PER YEAR

only those within a 1.5^o slice around Venuses plane can see it ONCE PER VENUS YEAR

A 0.7 ^o for MARS and within ~ 3^o s for MERCURY (only 8 PPM).

Proper motion will cause them to lose sight of us but see all planets!

- If at thousand L.Y away they will lose us in ~100 thousand years BUT
- Because of the different inclinations of the planets relative to the ecliptic (Venus 3.4, mars 1.8,Jupiter 1.3 Saturn 2.3 Mercury 7 degrees) will see us all in ~ 1 mega year AND
- Using also the wobble, with KNOWN periods they will find the p's masses/M(Sun)

But their wait will be worth it!

- Eventually they will find that we have a moon and tides help life ascend to land, and have oceans covering 70% of planet and (??) an Atmosphere. AND… JUPITER protects us from (most..) astroids . (No wonder the G/R revered him)
- Those in ~ 15 ^o s relative to the ecliptic (covering ~ 15 % of the sky) will see us in a Myr but because of our large angle relative to the galactic plane only ~ 1% of all ETI's are within this stripe

What are all the remaining 99% doing in the meantime?

- After the Kepler mission we suspect that most stars, including the lighter long lived K&M have planets in temperate regions (close to star for K@M type) so MOST ETI's not in the slice of the sky allowing the discovery of the solar system investigate the (many millions?) of planetary systems they discovered by transit. This may answer Fermi's Question: 'Where are they' A: Busy chasing others!

KEY 2: How will our discoverers approach us?

- In the big party by ‘Eye Contact”, by calling loudly, by buying the lady at the bar a drink, by shooting small paper clips etc. etc.
- SETI’s general answer: by sending “intelligent anti-encrypted signals” e.g. | | = || , || | =||| or the primes in binary etc.

But as in the big party setup chanting primes may be less effective than elaborating on shared common information.

We SHARE astronomical Information more so if discovered by transit!

- We and they know: the length of year and the maximal (across solar diameter) transit time for Earth and/or for Mars and /or Venus, etc.
- BACK TO THE MOTTO: we should NOT ask how WE find them and communicate with them but with well deserved HUMILITY ask how THEY will find us and communicate with us?

A Proposed answer by me, by Seth Shostak, by Subo Dong + more Is:

- They will find more info on us and be more likely to beam to us if they are within the 15 degrees stripe where the transit method can be used.
- They can send once every earth year two intense pulses separated by earth transit and every Venus year and separated by Venus transit etc. This indicates that they are targeting US.
- FURTHERMORE

By WHEN they send the signals they can point out their direction in the sky

- they need the distance to our sun of say thousand (light) years with few minutes – 1 hr uncertainty . The sun's brightness and their ingenuity may allow doing it !
- By looking at the anti-sun direction at the start pulse we can find their azimuthal \phi location within the above stripe
- if they are actually in the period of seeing the transit, also the polar location \theta can be accurately indicated.

So WE need to listen to radio/laser signals from the stripe of this simple pattern!

- Further confidence if direction indicated above does : 1) coincide with the physical direction of the arriving signal 2) point to a specific star in the sky and 3) we find a planetary system there.
- They can help us with that by sending us the lengths of years of the planets in their system

Key Observation: These simple signals can be the "Rosetta stone" of cosmic communications

- Once we find the carrier frequency chosen by that ETI we listen in this direction using the right frequency vastly improving reception and analysis of signals.

Key Question: Would they not be afraid to disclose their existence??

- Answer : Most likely not

- Natural selection of aggressive individuals e.g Genghis Khan. Cannot project colonialism onto ETI's as Hawking .
- Longevity of planetary societies requires peaceful "Collective" Genes, only such ETI's survive early childhood beset by nuclear dangers. SO THEY MAY NOT BE AFRAID!!

How is this connected to our kind of physics?

- It is not!
- except that Learned, Pakvasa and Tata suggested ETIS may use neutrinos for interstellar communication.
- 2 neutrinos of E > PeV and 26 with E ~ 0.2-0.3 PeV energies have been discovered at Ice-Cube! Explaining these by C.R's interactions or P.F. models seems difficult but they are less likely to be the first messages from ETI's….