AAS : Notes for Discussion 13th January, 2020

1) Missions: planned for the 2020s:-

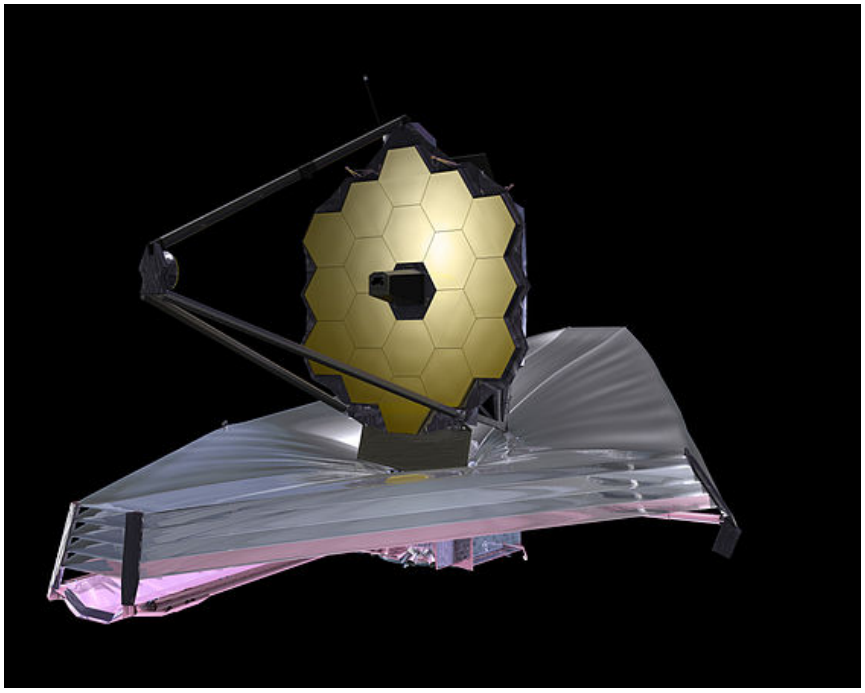
Both NASA and the ESA have Mars rovers planned for launch in 2020.

NASA's Mars2020 rover is scheduled for launch in July this year with a landing date of 18/02/21. It has 4 science objectives, studying Mars' habitability, seeking signs of past microbial life, collecting and caching samples, and preparing for future human missions.

Meanwhile ESA's ExoMars mission, also launching in July, with a landing date of March next year, consists of an ESA rover and a RosComos surface platform. Equipment includes an exobiology laboratory and a 2m drill for core samples.

Between 2021 and 2025 four infra red space telescopes are planned.

2021 it is hoped that the James Webb will finally get off the ground and be placed at the L2 Lagrange point. The successor to the HST it is going to be looking at the formation of galaxies, stars and planets as well as imaging exo-planets.



Then in 2022 ESA hope to launch the EUCLID mission. It's objective is to shed some light on Dark Matter and Dark Energy by looking at the acceleration of the universe.

SPHEREx, launch 2023/24(?), is intended to obtain spectra for 450+M galaxies from the early cosmos.

Finally we have WFIRST in 2025, investigating Dark Energy and a census of exo-planets, inc life potential.

A bit closer to home there are 3 planned moon missions.

Lunar Flashlight, looking for water deposits, launch 2021, Chandrayaan 3, India's 2nd attempt to land, 2020, and NASA's Artemis Program to return to the moon by 2025 kicks off in 2022 with VIPER, looking for lunar resources.

Finally there are 2 solar system projects:

Psyche, due to land on this metallic asteroid in 2023, and Europa Clipper, hoping to reach the icy moon of Jupiter in 2026 or 2028 to explore the moon and it's habitability.

2) Exo-planets:

Since the first confirmed exo-planet in 1992 over 4,000 exo-planets are now confirmed, and many more to be checked. An animation of year against discovery, with added sound, can be seen at YouTube.

There have been a number of space telescopes, eg Kepler and TESS. Now ESA has joined in with the launch of Cheops last December. Its' mission is to measure the size of known transiting exoplanets orbiting bright and nearby stars as well as to search for transits of exoplanets (planet passing in front of star) previously discovered via radial velocity (looking for a star's wobble). These data allow the size, mass and density of an exo-planet to be determined. It can also be fed into other missions, eg JWST, for further investigation, eg spectra.

Speaking of TESS, above, it has been looking long enough to study a number of transits of HD118203b, discovered in 2006 by radial velocity. Whilst detecting a wobble, using red and blue shifts, can happen at any orientation a transit can only be seen if the planet passes directly between us and its' star.

TESS has also just discovered its' first earth size planet that may have oceans and a planet orbiting two stars.

Having only 1 solar system 30 years ago to study we assumed that, if there were other systems, they would obviously follow the pattern of our. But since 1992 it has become clear that our system is the strange one. We have no "hot Jupiters" with orbits of days, planets in double star systems, orbiting neutron stars, a handful of earth size rocky planets and a handful, if that of habitable planets, as we understand habitable that is. Much of our assumed theories have been called into question. There is clearly a lot more to discover.

Other topics we could look at, if we have the time and/or inclination include:-

3) The Milky Way

Two recent claims/observations about our galaxy:

First ongoing studies of star movements around Saggitarius A*, the supermassive black hole in the MW, have led an astrophysicist to suggest that we have a second black hole at the centre of our galaxy, some 100,000+ times the mass of the sun. That compares with the known black hole which is some 4 million times the mass of the sun.

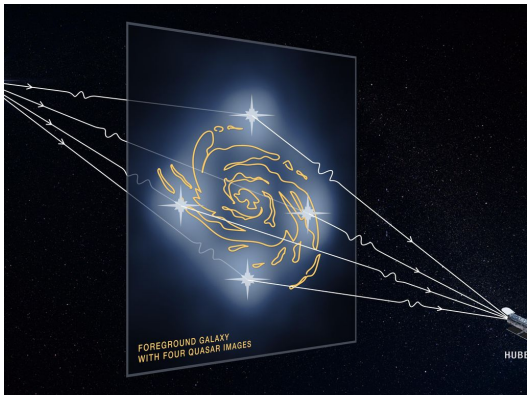
Second astronomers at Harvard have discovered a wave shaped gaseous structure which is made up of interconnected stellar nurseries. The study, published in *Nature*, uses Gaia data to discover this structure, 9,000 x 400 Ly, in the spiral arm closest to us. This discovery is forcing a rethink about the galaxy's 3D structure. Our vision of nearby stellar nurseries as a expanding ring has been replaced by one consisting of an undulating star forming filament.

4) Dark Matter

The search continues to try and find out what Dark Matter is.

A new Hubble study concludes that DM can exist in small clumps and is colder that we thought at smaller scales. This reinforces the ΛCDM (Cold Dark Matter with a cosmological constant) which is our current theory for haw the universe developed from the time of inflation.

The study used the phenomenon of Einstein Crosses, the view we get of distant objects subject to gravitational lensing.



Another small step to answering the question!