

“Astronomy is more than a spectator sport”

**“where we are going (Pt 2)” &
getting involved in astronomy**

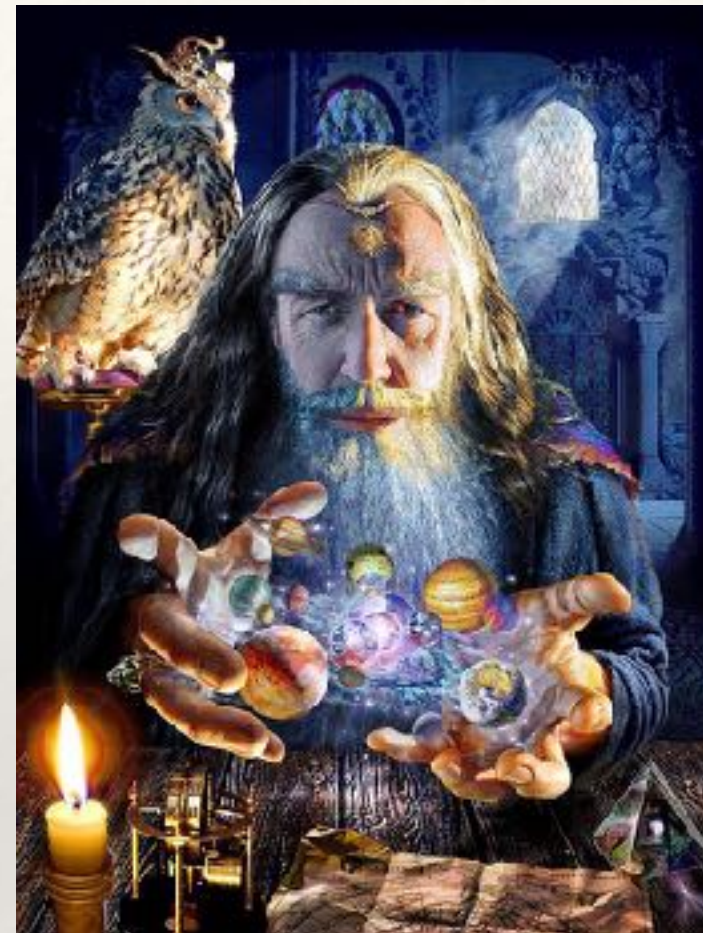
Tim Ewbank
15th May 2017

*“To know where we’re going,
we have to know where we are.
To know that, we have to know where we came from
& how we got here”*

Recap from last class

Personal observing

- What you will need
- Equipment & information



How will it all end?

- Earth
 - Solar system
 - Galaxy
 - Universe
-
- Homework assignment

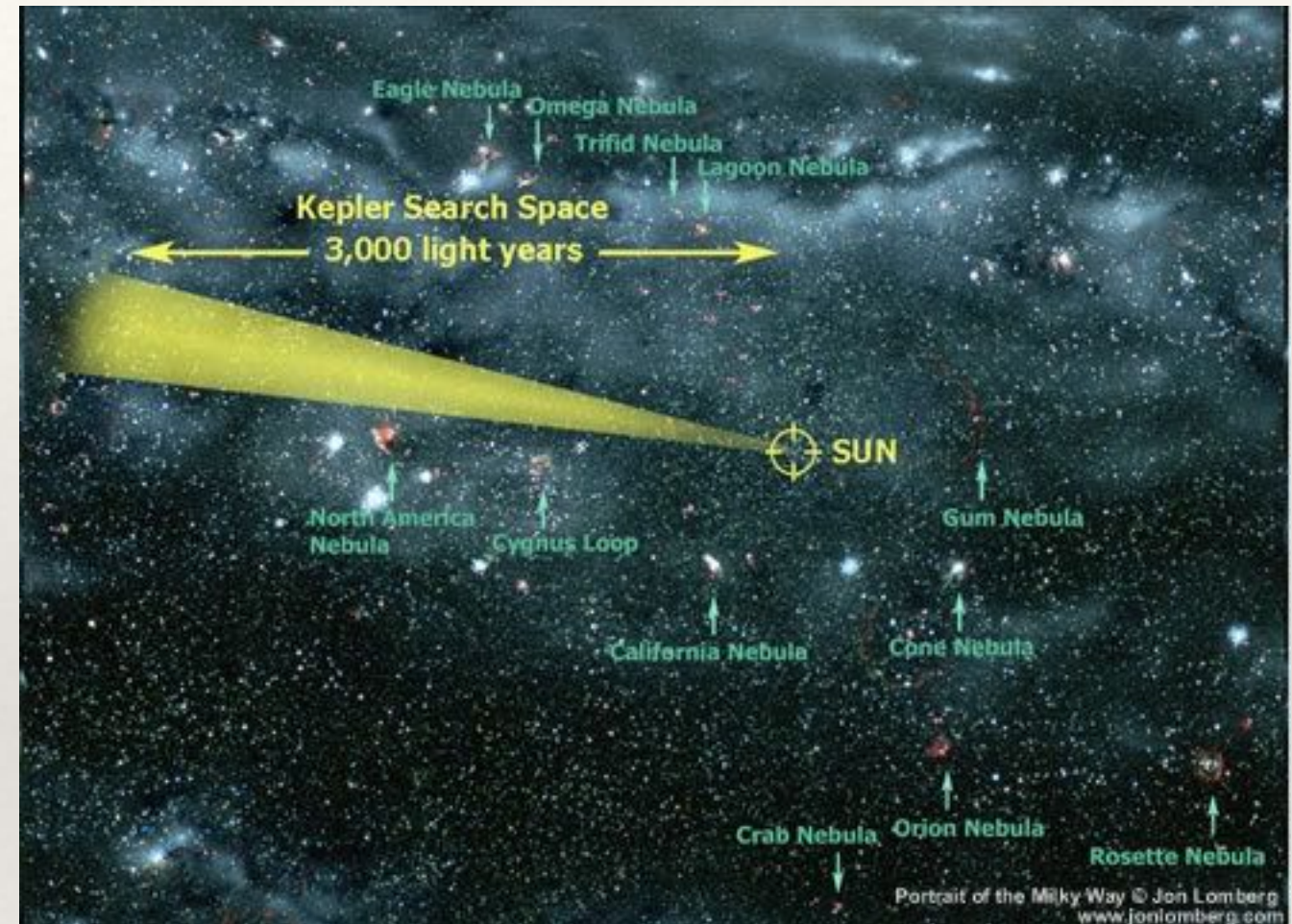
Agenda for today

- ❖ Current research directions
- ❖ Astronomical activities for all ages & interests
- ❖ Review of the course



SETI - Methods & Scope

- ❖ First exoplanet discovered 1995
- ❖ Goal is to find earth like planets (exoplanets) circulating a star within “habitable zone”
- ❖ Three primary search methods:
 - radial velocity
 - transit light curves
 - gravitational micro-lensing

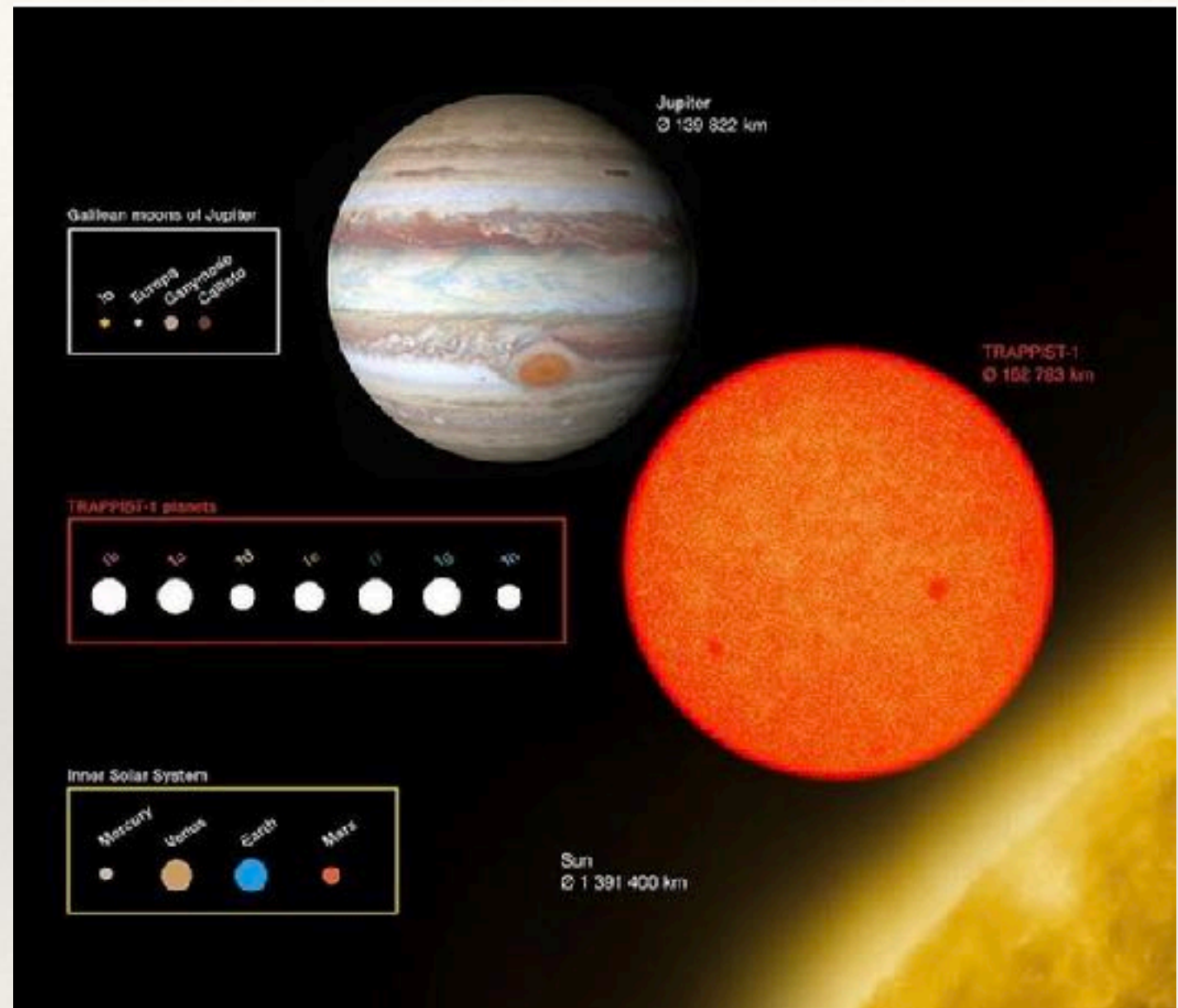


Search area is within Milky Way (furtherest 27×10^3 ly))

Main telescopes used Kepler, HARPS, Las Cumbres Global Telescope Network

Exoplanet Search Results to date

- ❖ 3,468 discovered by 15th May 2017
- ❖ >60% discovered since 2014
- ❖ Majority by transit method (esp'ly recent discoveries)
- ❖ Until recently, mainly “hot Jupiters”
- ❖ TRAPPIST-1 & Centaurii Proxima



Images are “artist’s impressions”

Martin Rees opinion that we will image directly within 10yrs



Drake's Equation

The Drake Equation

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

N = The number of civilizations in The Milky Way Galaxy whose electromagnetic emissions are detectable.

R^* = The rate of formation of stars suitable for the development of intelligent life.

f_p = The fraction of those stars with planetary systems.

n_e = The number of planets, per solar system, with an environment suitable for life.

f_l = The fraction of suitable planets on which life actually appears.

f_i = The fraction of life bearing planets on which intelligent life emerges.

f_c = The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.

L = The length of time such civilizations release detectable signals into space.

U3AC application of Drake's Equation

	Rate of star formation	Fraction with planets	No. planets that CAN support life	No. planets that DO support life	Fraction that develop intelligent Life	Fraction of communicative civilisations	Duration of civilisations
Units	# stars (bn)	%	# planets	%	%	%	# years
High	50	30	1	30	20	50	1,000,000
Low	1	0.0001	0.1	0.1	0.0001	1	1000

Collective prediction

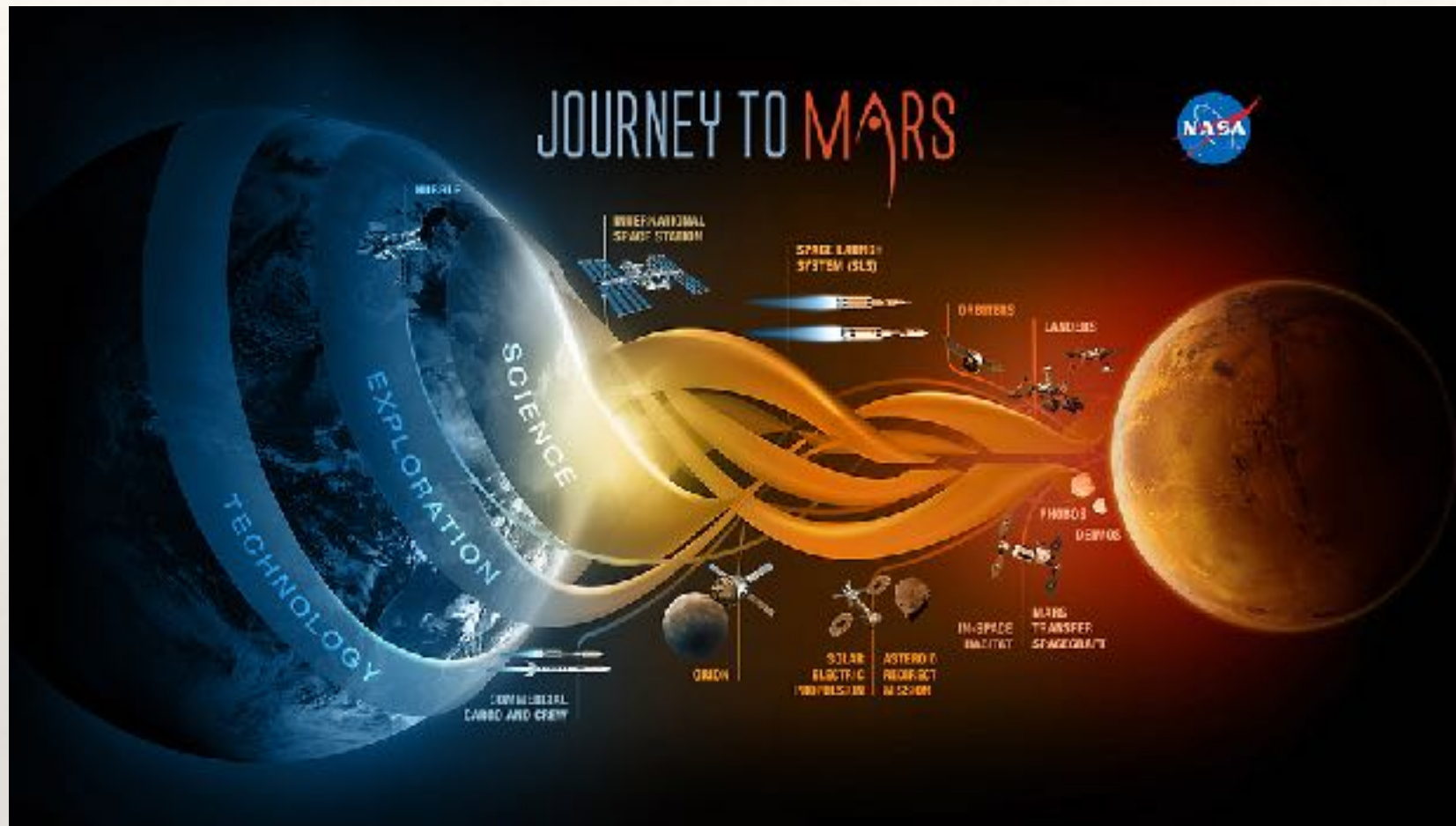
No. of communicative civilisations in The Milky Way = 720 to 2×10^{-11}

Attitudes to SETI outcome

<http://www.ice.cam.ac.uk/what-we-do/madingley-lectures/life-in-the-cosmos>

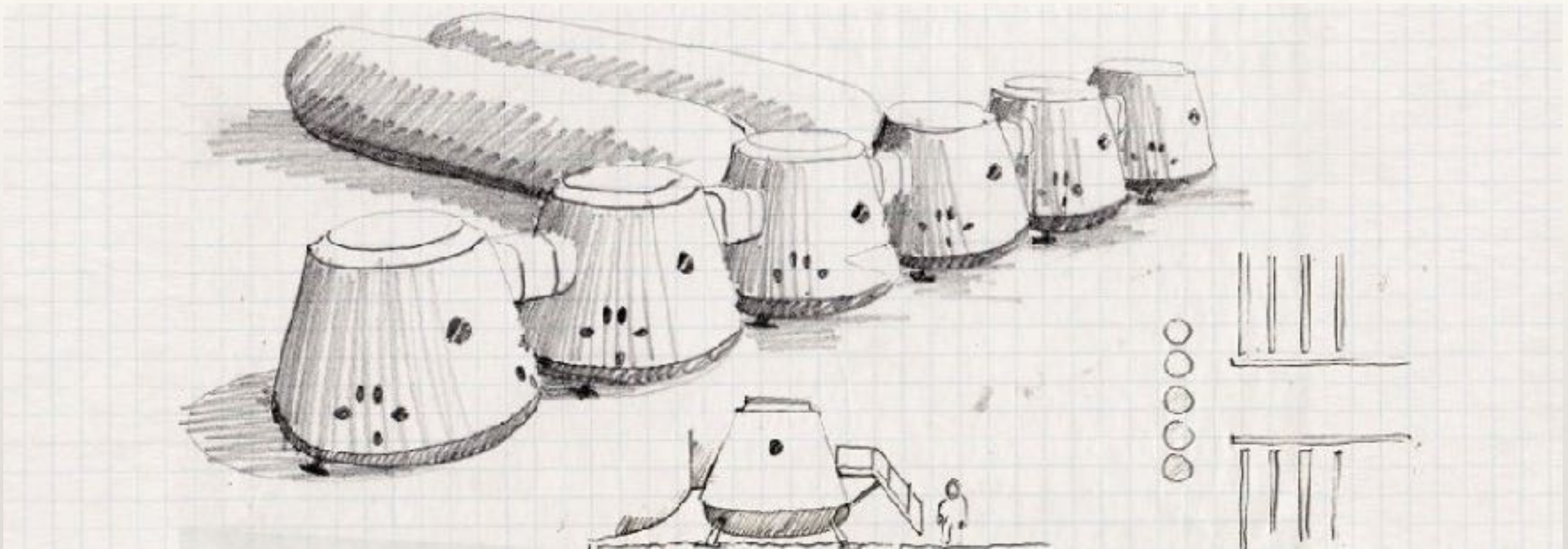


Space Exploration



- ❖ Future, more likely to be robotic than human, but:
 - “NASA is developing the capabilities needed to send humans to an asteroid by 2025 and Mars in the 2030s”
- ❖ Solar Electric Propulsion technology critical
- ❖ Focus is on origins of solar system & search for life
- ❖ Risk of contention is valuable resources discovered on Moon

Mars One project



- ❖ Plan for manned colony by 2031 proposed by Dutch NFP
- ❖ 2,700 initial applicants for one-way trip (whittled down to 100 in Feb 2015; next phase is 100 to 24 during 2017)
- ❖ Success deemed technically doubtful & funding status unclear

Telescopes

❖ Need to observe very faint, distant objects, which require ever-bigger terrestrial scopes.

❖ Tech challenges:

- precision of support for primary mirror
- rigidity of mirror (10^{-6} inch)
- temperature control
- Cost/image quality relationship is log-shaped

❖ Major technical developments:

- ❖ adaptive optics (VLT & Keck)
- ❖ multi-object spectroscopy
- ❖ multi-site radio interferometry

can be effectively combined

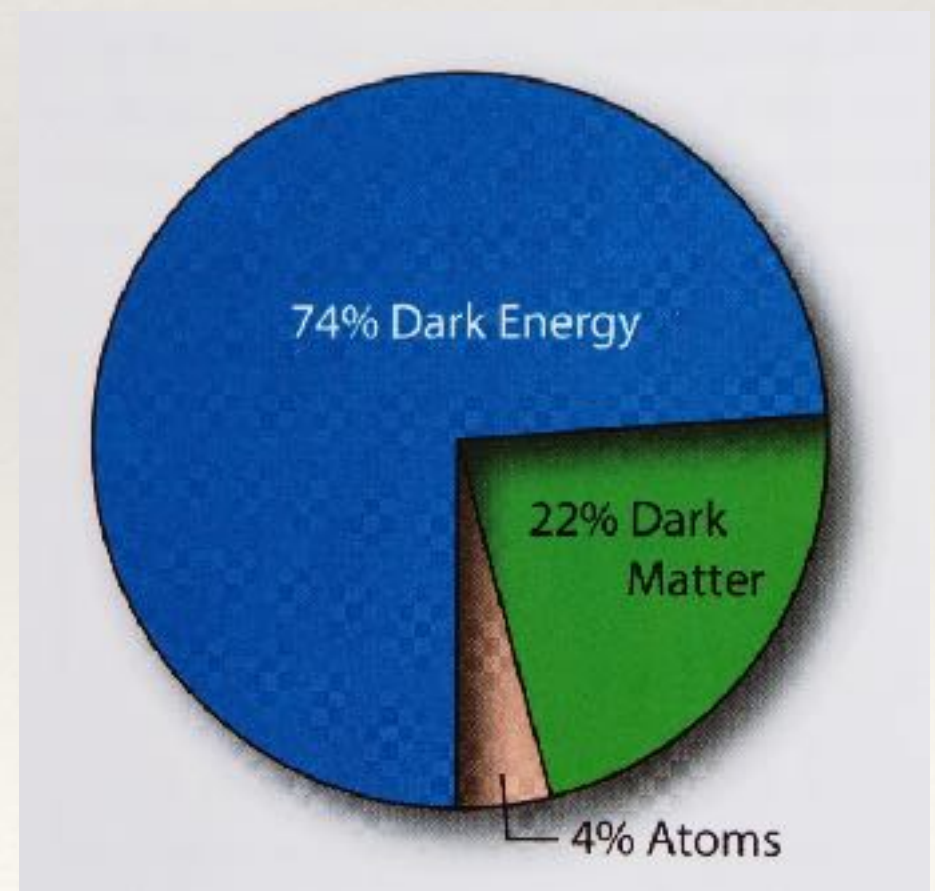
Several large scopes planned:

- Xingjiang Qitai 110m Radio Telescope (QTT)
- Thirty Metre Telescope (TMT) Hawaii
- European Extremely Large Telescope (E-ELT)
- Giant Magellan Telescope (GMT)
- James Webb Space telescope (JWST) successor to Hubble. estimated cost \$8billions by launch in 2018
- Networks of linked telescopes e.g. Les Cumbres (5 scopes across the globe)



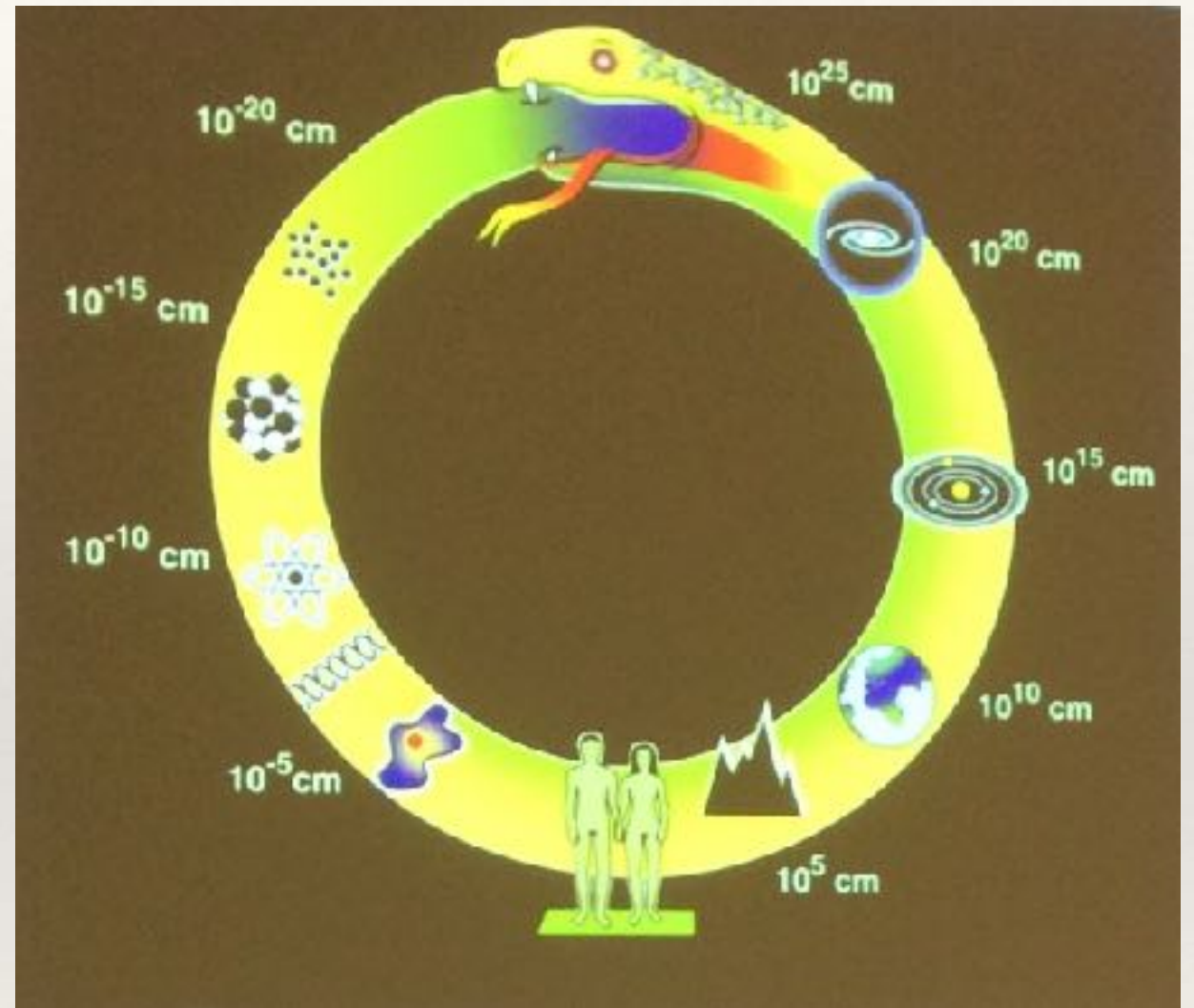
Dark Matter & Dark Energy

- ❖ Unexplained invisible "dark matter" first postulated in 1937 by Fritz Zwicky, Caltech
 - ❖ Findings confirmed by different method in 1974s (mass-to-light ratios) of galaxies
 - ❖ Existence shown by 3rd method in 1980s (rotational velocities of galaxies)
 - ❖ Now accepted as proven, but its nature remains unknown
- ❖ An invisible repulsive force that is believed to be driving the accelerating expansion of the universe.



A Theory of Everything (aka Grand Unified Theory)

- ❖ A single theory which combines the the world of the very small (quantum mechanics) with the very large (General Relativity)



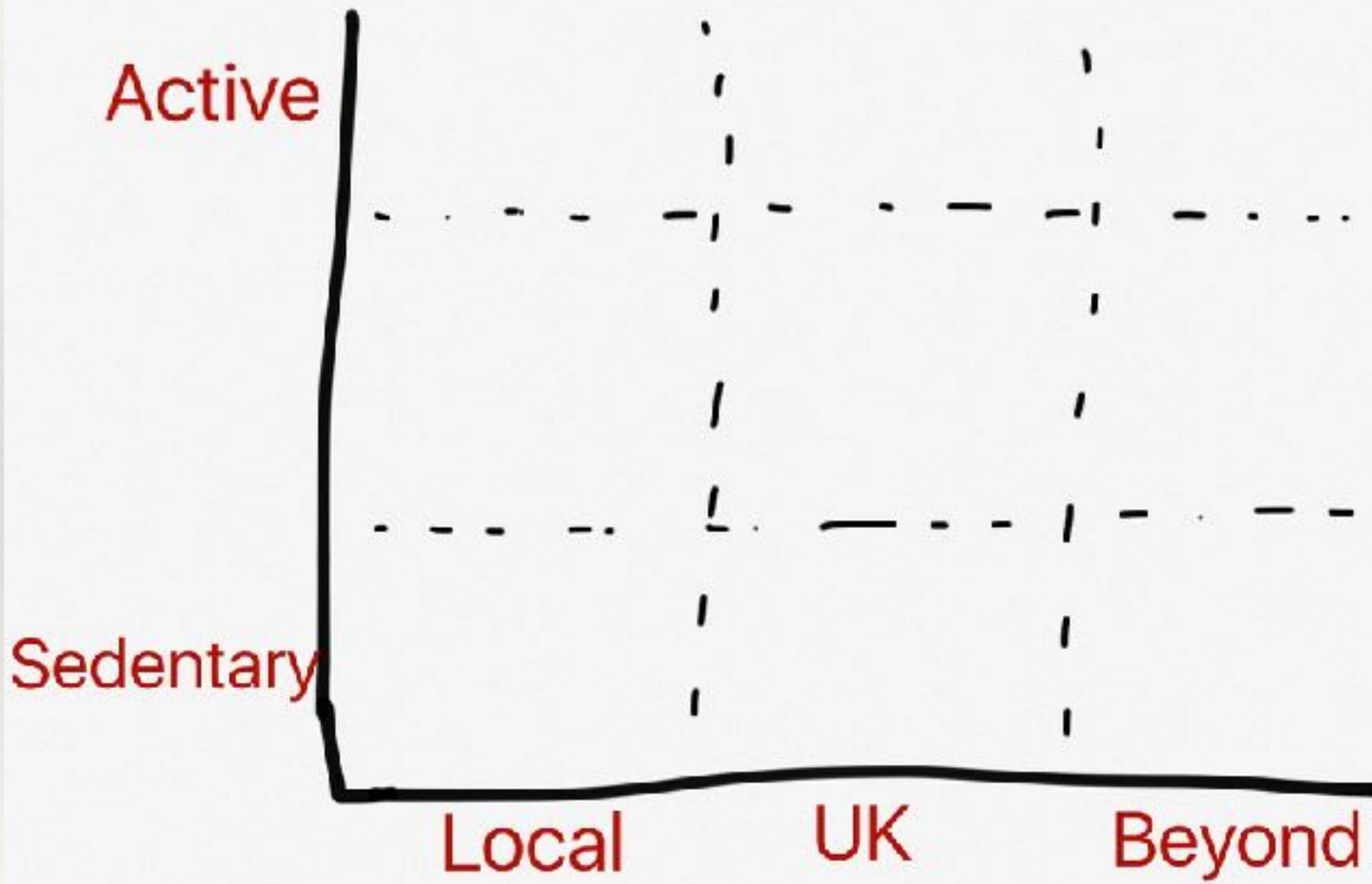
(General Relativity)
quantum mechanics) with the very large (General Relativity)

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How involved do you want to be from here on?



Ways of getting involved in astronomy



Astronomy related links (1 of 4)

Observing

- **Astro Clubs**
 - **CAA**
 - <http://www.caa-cya.org/newversion/>
 - **Ely**
 - <https://sites.google.com/site/elyastroclub/>
 - **St Neots**
 - <https://sites.google.com/site/stneotsastronomyassociation>
- **Professional telescopes**
 - **Faulkes Telescope**
 - <http://www.faulkes-telescope.com>
 - **Las Cumbres Observatory Global Telescope Network (LCOGT)**
 - <http://lcogt.net>
 - **Palomar**
 - <http://www.astro.caltech.edu/palomar>

Astronomy related links (2 of 4)

Astro News

- **Portal to the Universe app (accessible from Apple App Store)**
- **Institutes & Agencies**
 - <http://www.nasa.gov>
 - <http://www.esa.int/ESA>
 - <http://www.seti.org>
 - <http://www.ligo.org>
 - <http://www.ast.cam.ac.uk>
- **Space missions e.g.**
 - <http://sci.esa.int/gaia/>
 - <http://www.jwst.nasa.gov>
 - <http://hubblesite.org>

Societies & clubs

- **British Astronomical Assocn**
 - <http://www.britastro.org>
- **Society for Popular Astronomy**
 - <http://popastro.com>

Astronomy related links (3 of 4)

Excursions

- UK Local
 - National Space Centre
 - <http://www.spacecentre.co.uk>
 - Royal Observatory
 - <http://www.rmg.co.uk/royal-observatory>
 - Jodrell Bank
 - <http://www.jb.man.ac.uk>
- Further afield
 - USA
 - Kennedy Space Center
 - <https://www.kennedyspacecenter.com>
 - National Air & Space Museum
 - <http://airandspace.si.edu>
 - US observatories
 - <http://www.go-astronomy.com/observatories.htm>
 - European astro tourism
 - <http://astrolapalma.com>
 - world observatories
 - https://en.wikipedia.org/wiki/List_of_astronomical_observatories

Astronomy related links (4 of 4)

Further study

- CAA courses & talks
 - <http://www.caa-cya.org/newversion/events.php?who=caa>
- <http://www.ice.cam.ac.uk/courses>
- iTunesU (accessible from iTunes main menu)

Talks

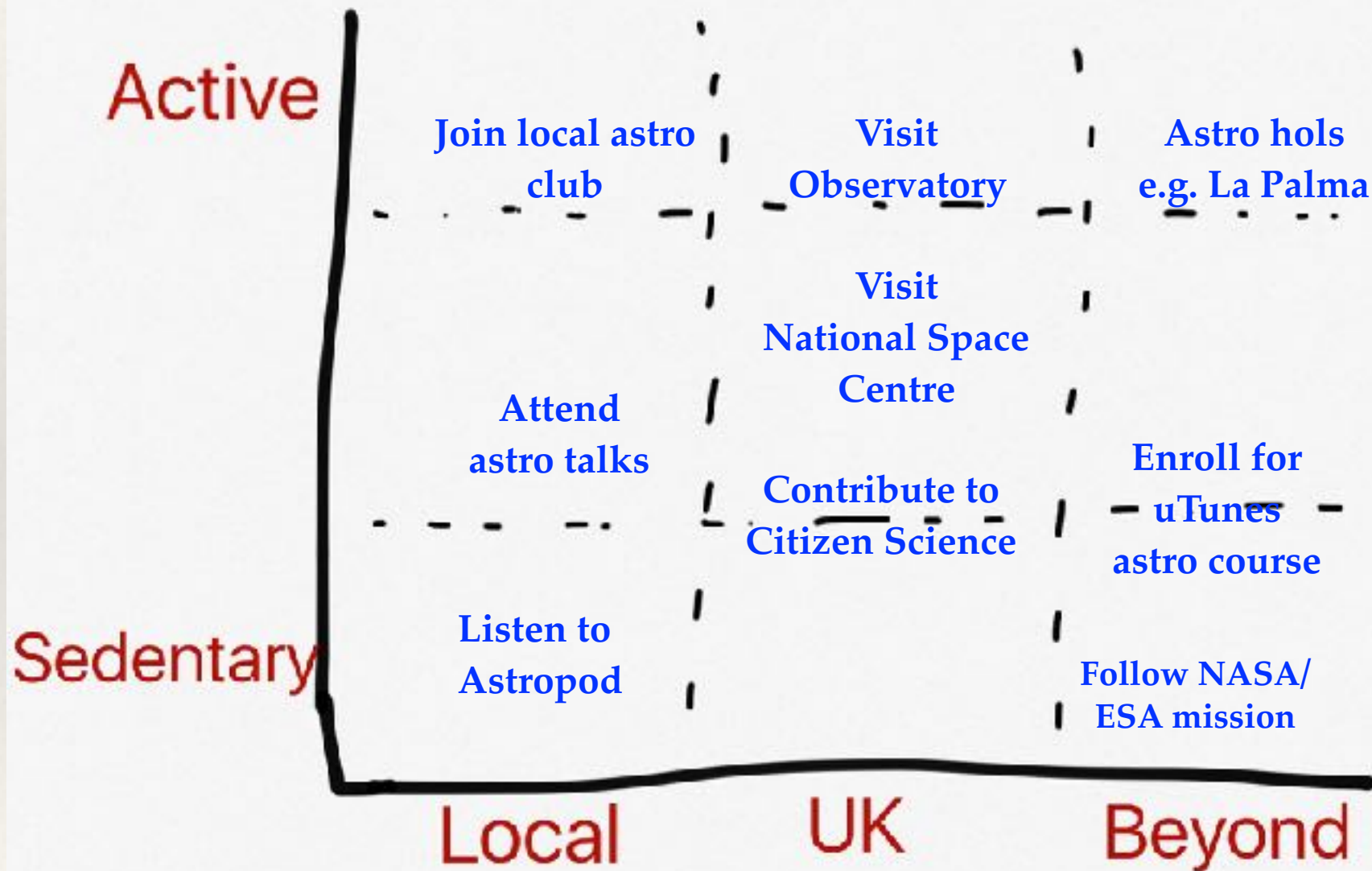
- astronomy podcast
 - <http://www.astronomycast.com>
- Local
 - <http://talks.cam.ac.uk>
 - <http://www.darwin.cam.ac.uk/lectures>

Citizen Science

- Zooniverse
 - <https://www.zooniverse.org/projects>
- Agent Exoplanet
 - <http://lcogt.net/agentexoplanet/>

<https://www.zooniverse.org>

Examples of degrees of involvement

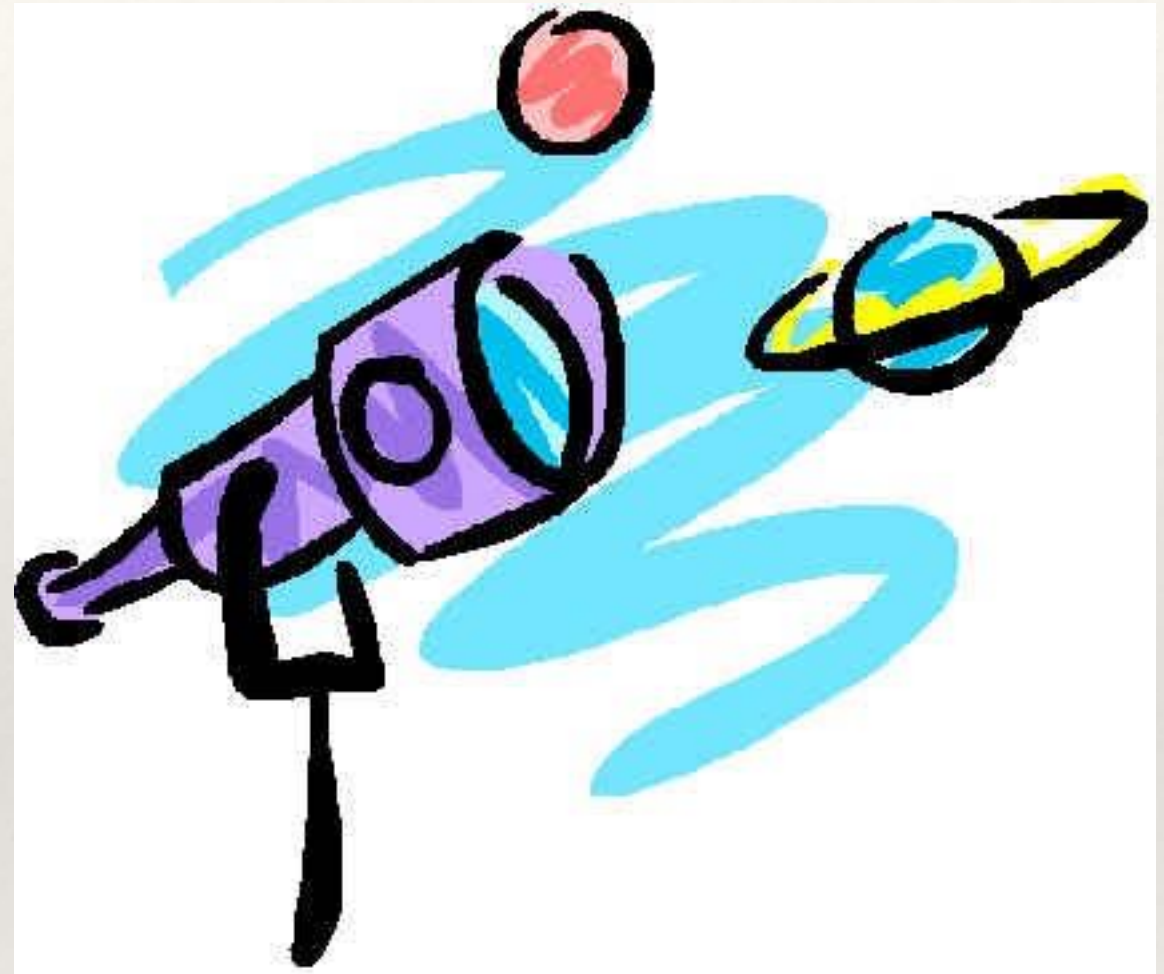


*That's All
Folks!*



Course Objectives

- ❖ Present a *wide-angle* view of astronomy
- ❖ Stimulate your interest in some new area of astronomy
- ❖ Encourage your participation
- ❖ Share sources and experience
- ❖ Learn from each other



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To know that, we have to know where we came from & how we got here”

How I thought it might be...



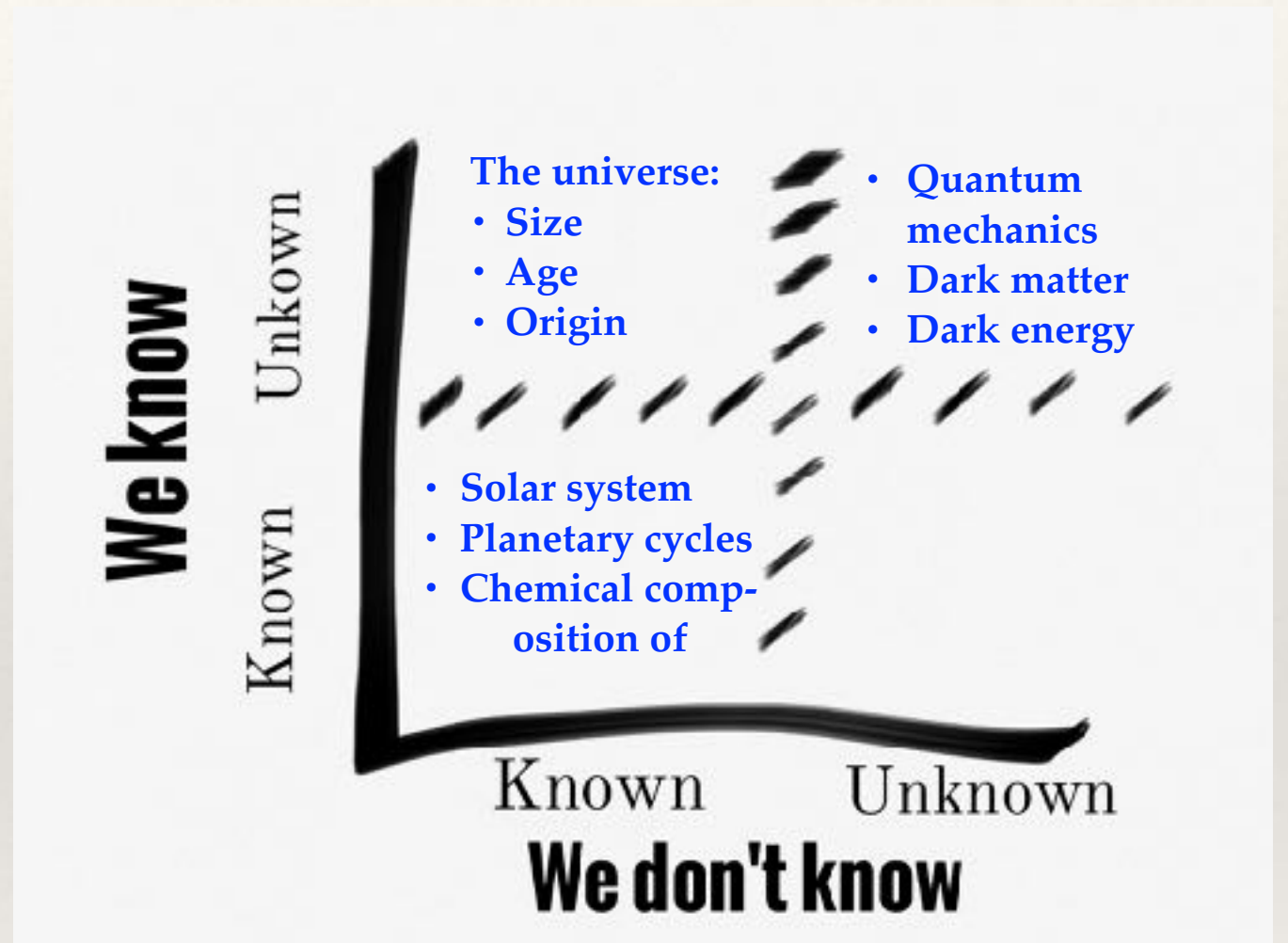
“where we are”

- ❖ Introduced astronomical scale
- ❖ Explained the spatial arrangement of 4 tier hierarchy of the universe:
 - Our solar system
 - Milky Way galaxy
 - Clusters & super-cluster
 - the universe
- ❖ Described the temporal development of the universe



“where we came from & how we got here”

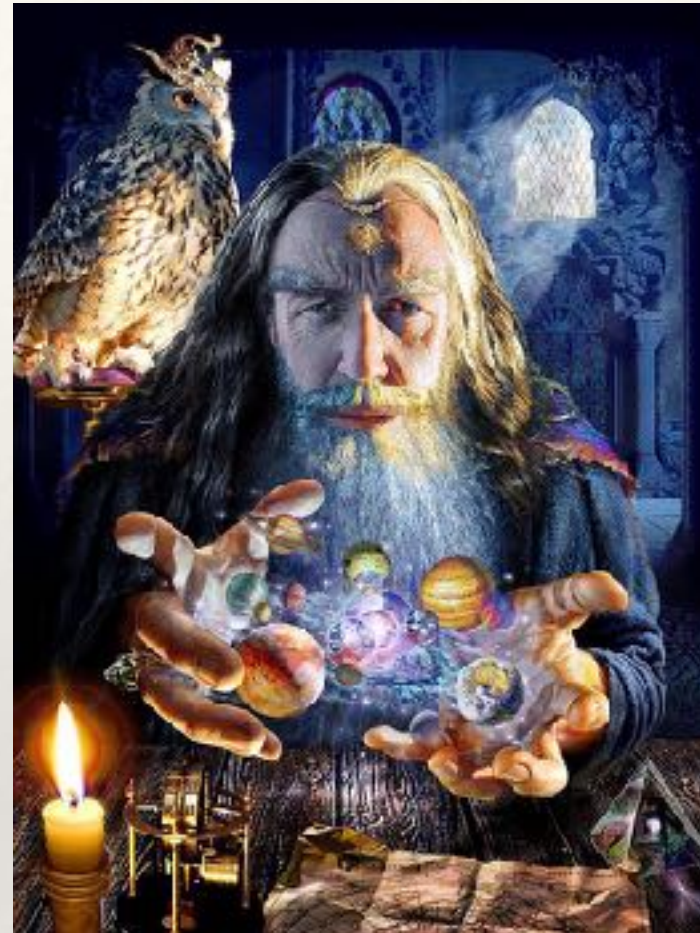
- ❖ Describe relationship between technological developments & progress of astro knowledge
- ❖ Explain developing understanding:
 - solar exploration
 - stellar evolution
 - development of galaxies
 - origins of the the universe



“where we’re going” (Pt 1)

Personal observing

- What you will need
- Equipment & information



How will it all end?

- Earth
- Solar system
- Galaxy
- Universe

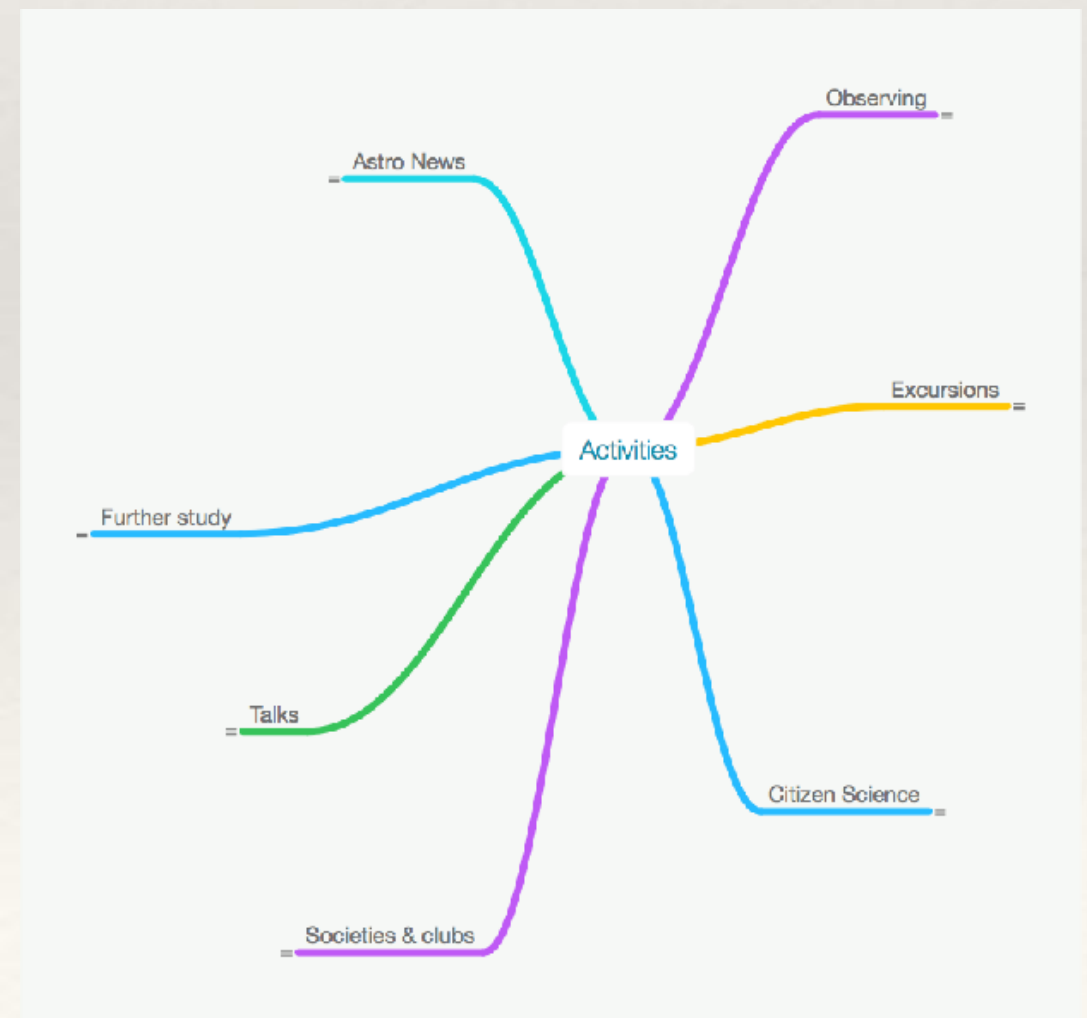
- Homework assignment

“where we’re going” (Pt 2)

Current Research Directions

- Search for Extra-Terrestrial Intelligence (SETI)
- Space exploration
- New telescopes
- Dark matter
- Dark Energy
- Theory of Everything

Ways of getting involved in astronomy



Closing thoughts

WE ARE JUST AN ADVANCED BREED OF MONKEYS
ON A MINOR PLANET OF A VERY AVERAGE STAR.
BUT WE CAN UNDERSTAND THE UNIVERSE. THAT
MAKES US SOMETHING VERY SPECIAL.

S T E P H E N H A W K I N G



*“Our greatest intellectual
achievement is understanding
our place in the universe”*

Prof. Brian Cox “Human Universe”

“Astronomy is more than a spectator sport”



A word cloud featuring various phrases for saying goodbye. The words are arranged in a dense, overlapping manner. The largest words are 'goodbye', 'thankyou', 'regards', 'sayonara', and 'ciao'. Other prominent words include 'farewell', 'cheerio', 'seeya', 'cheers', and 'adieu'. Smaller words include 'godspeed', 'conclusion', 'culmination', 'so long', 'Arrivederci', 'Au-revoir', 'leave-taking', 'envoi', 'Auf-wiedersehen', 'bye-bye', and 'codas'. The colors range from light blue to dark purple.

goodbye
thankyou
regards
farewell
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sayonara
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