Science Programme

Through our ESA and national investments we have:

In Orbit Operations

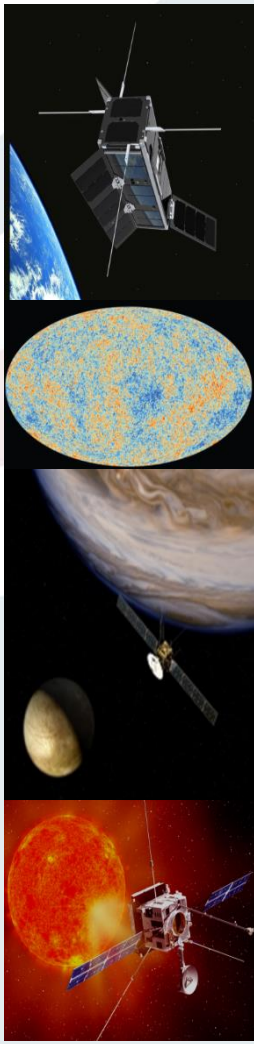
- Completed science phases of Planck and Herschel
- Continued operations of Rosetta, Swift, Hinode, Stereo, & GAIA
- Planning operations for Solar Orbiter and BepiColombo
- Launched and operating Ukube-1

Under Development

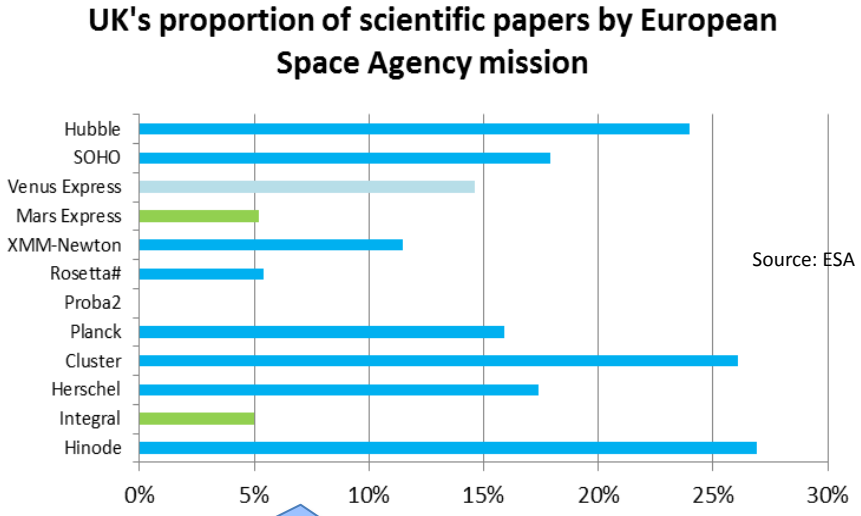
- Completed flight instruments for JWST (MIRI), BepiColombo (MIXS), LISA PathFinder (LTP) and micro-seismometer on InSight
- Solar Orbiter instruments (M1), VIS Camera and Science Ground Segment on Euclid (M2) and the Exomars instruments
- Secured lead role on magnetometer for JUICE (L1)
- Secured £20M new science capital funding for Plato (M3)

Future Opportunities

- Planning UK participation in M4, SMILE (S2) and Athena (L2) subject to national budgets



ESA membership generates excellent science



Blue missions are ones where the UK had Principal Investigator (PI) status : national funding directly leads to better returns

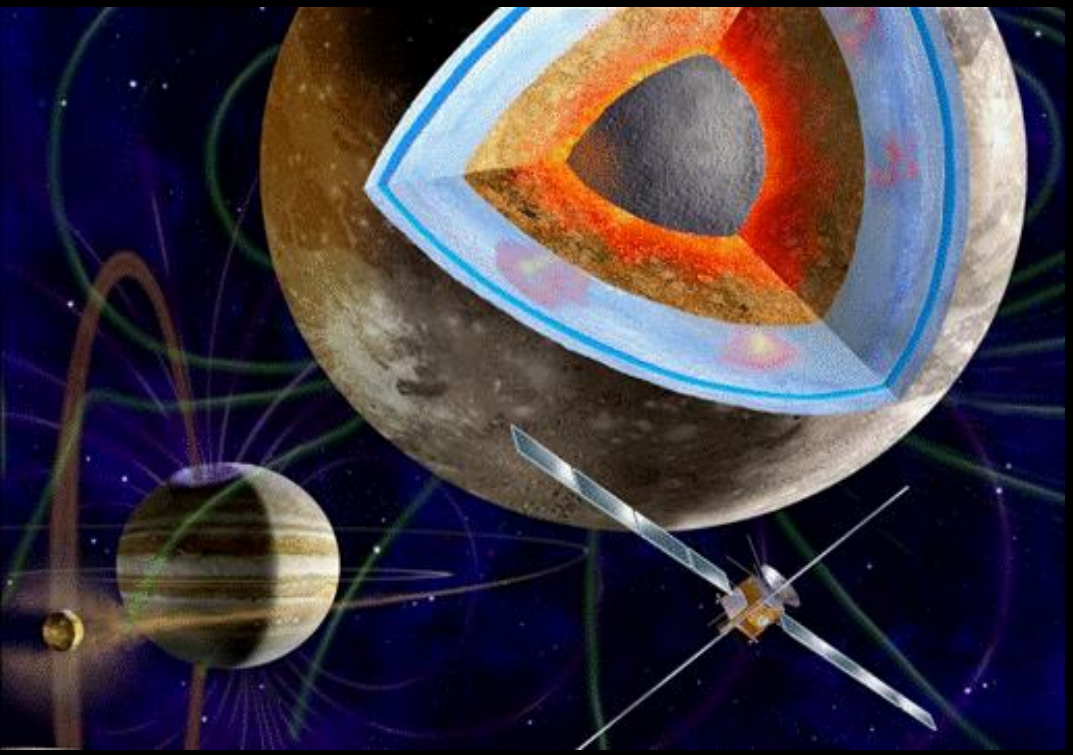
SPIRE instrument being built at Cardiff university.

UK scientific outputs with ESA are higher when the UK has a Principal Investigator or an instrument on one of the ESA mandatory core missions. These instruments are funded out of the UK Space Agency National budget.

Professor Matt Griffin at Cardiff university received £11 m to develop the SPIRE instrument which was one of three that flew on the £1 bn ESA Herschel Space telescope.

18% of all scientific papers on Herschel are UK authored and on SPIRE related papers they are 24% UK authored. In total 58% of Herschel scientific outputs had UK scientists involved.

Not just excellent science: the company QMCI was spun-out as a result of work.



JUICE Science Themes

- *Emergence of habitable worlds around gas giants*
- *Jupiter system as an archetype for gas giants*

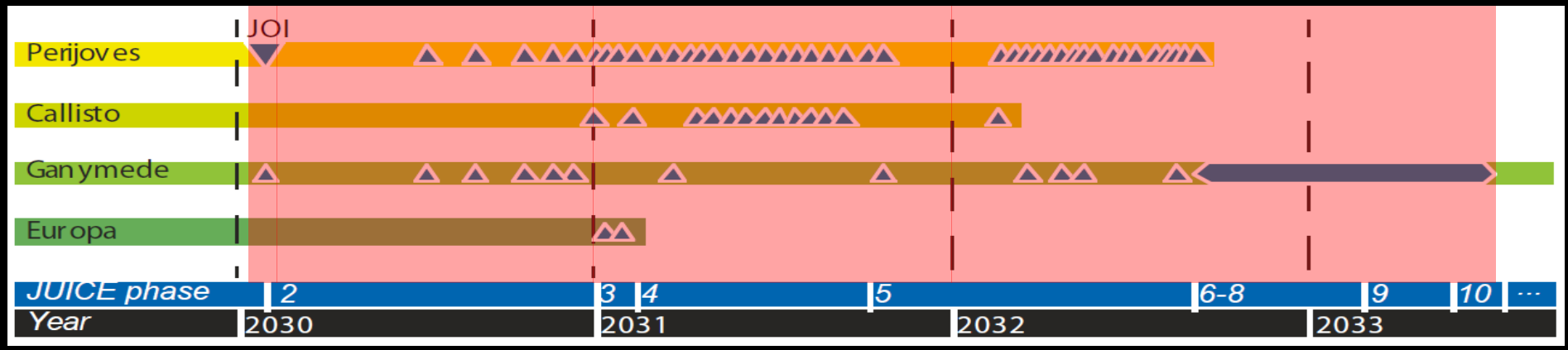
JUICE concept

- *European-led mission to the Jovian system*
- *Two Europa flybys and high-inclination phase at Jupiter*
- *10 Callisto flybys, orbits Ganymede*
- *First orbiter of an icy moon*

Mission scenario overview

Launch	06.2022
1. Interplanetary Transfer	7.6 years
Jupiter Orbit Insertion	01.2030
2. Jupiter equatorial phase #1	~11 mon
3. Two Europa flybys	36 days
4. Jupiter high-latitude phase including Callisto flybys	260 days
5. Jupiter equatorial phase #2	~11 mon

Ganymede phases	
6. Elliptic #1	30 days
7. High altitude (5000 km)	90 days
8. Elliptic #2	30 days
9. Circular (500 km)	102 days
10. Circular (200 km)	30 days
Total mission duration	**11 years**



Exploration of the habitable zone

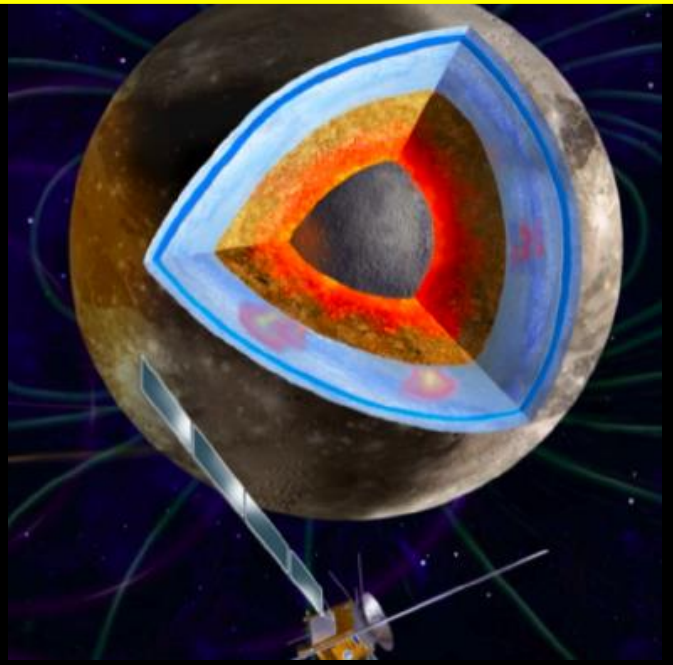
JUICE

Three large icy moons to explore

Ganymede

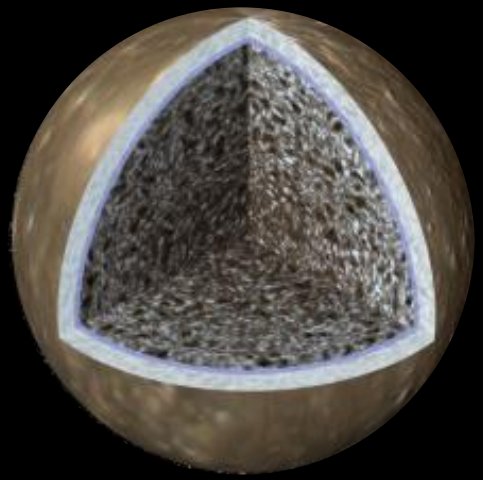
- Largest satellite in the solar system
- A deep ocean
- Internal dynamo and an induced magnetic field – unique
- Richest crater morphologies

- Archetype of waterworlds
- Best example of liquid environment trapped between icy layers



Callisto

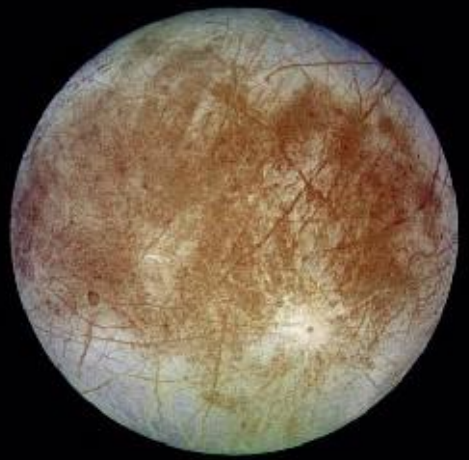
- Best place to study the impactor history
- Differentiation – still an enigma
- Only known example of non active but ocean-bearing world
- The witness of early ages



Europa

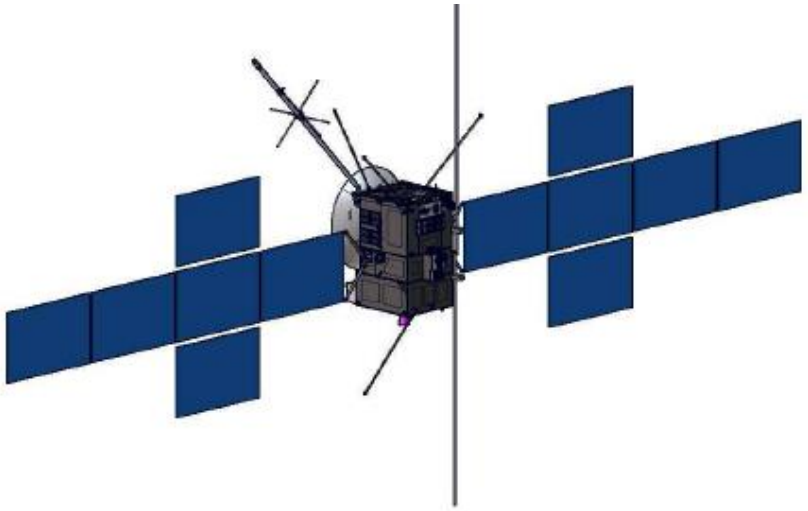
- A deep ocean
- An active world?

- Best example of liquid environment in contact with silicates

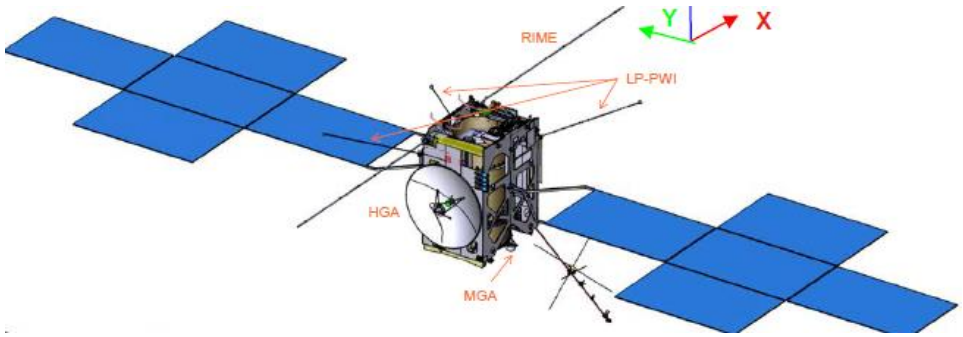


Spacecraft consortia & configuration

- Two consortia bidding and under evaluation
  - Airbus DS (F) with Airbus GmbH (D)
  - Thales Alenia Space (F) with OHB (D)



- Main resources
  - Mass
    - ✓ Dry ≈ 2200 kg
    - ✓ Propellant ≈ 2900 kg
    - ✓ Total > 5000 kg
    - ✓ Instruments: 218 kg
  - Power
    - ✓ Total < 1000 W
    - ✓ Instruments GCO500 =180 W
    - ✓ Instruments fly-by = 230 W (360 W for ½ h)
  - Memory = 500 Gbit EOL (SSRD requirement)
  - Δv ≈ 2700 m/s
  - Data Rate: 1.4 Gb/24 h



Summary

- UK Investment produces excellent science
- Long term stability and planning needed to develop technology and implement challenging missions
- UK involvement/leadership in ESA's L, M and S class missions
- Potential bilateral missions or missions of opportunity more difficult to plan for, another funding line for these?