ESA’s Science programme
Opportunities for Venus missions

Colin Wilson
Oxford University

VEXAG meeting, 20 Nov 2013

Picture: Lava on Etna, with Catania in the background
ESA’s Science program

ESA Mandatory Science program, to which all member states contribute, includes:

- L-class missions
- M-class missions
- S-class missions
- Missions of opportunity

There is also an optional Mars Robotic Exploration Preparation (MREP) Programme:
- Includes the ExoMars 2016 & 2018 missions
- Future mission options include Moon & Mars missions.
- Optional nature of the programme means that countries can vary at will the level of their contribution.
**L-class missions (~1000 MEuro)**

- **L-class missions** have a cost cap of ~1000 MEuro
  - **L1 (2022 launch):** JUICE mission to Jupiter
    - Runners up were ATHENA (X-ray astronomy) and LISA (gravity wave detector)
  - **L2 (2028 launch)**
  - **L3 (2033 launch)**

- **April 2013:** Call for White Papers to define Science Themes for L2 and L3 missions
L2/L3 Science theme white papers

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  Three out of thirty white papers advocated Venus exploration:
  Papers were led by Limaye, Marcq, Wilson. Presentation made in Paris Sep 2013.

Venus: A Natural Planetary Laboratory
Case for ESA’s Cosmic Vision L2/L3 Mission to Venus to Learn about Other Terrestrial ExoPlanets

Spokesperson:
Barbey S. Limaye
University of Wisconsin
Space Science and Engineering Center
1222 W. Dayton St., Madison, Wisconsin 53706, USA
+1 608 263 7601 (Office)
+1 608 262 5615 (Fax)
barbey@ssc.wisc.edu

White paper for an ESA L2 or L3-class mission
"Europe returns to Venus"
Emmanuel Marcq
emmanuel.marcq@ionn.noe.u-psud.fr
Deadline 2013-09-26

Venus: Key to understanding the evolution of terrestrial planets
A response to ESA’s Call for White Papers for the definition of Science Themes for L2/L3 Missions in the ESA Science Programme

Spokesperson: Colin Wilson
Astrophysics, Earth and Planetary sciences, Chemical and Material Sciences
University of Oxford, UK
Email: colin.wilson@astro.ox.ac.uk
L2/L3 Science theme white papers

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All three of us advocated Orbiter + In Situ element(s).

In particular, my paper suggested a focus on understanding the evolution of Venus, using:

- **InSAR-equipped orbiter** to study geological record of history
  - Orbiter also carried LIDAR, UV & IR spectrometers, cameras for atmospheric science
- **In situ (balloon) measurements of noble gas isotopes** to study pre-geological history
  - Balloon also carried chemistry & meteorology package to characterise cloud-level processes.
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And the winner is ...
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  - L1 (2022 launch): JUICE mission to Jupiter
  - L2 (2028 launch): to address “the hot and energetic universe”
    - e.g. X-ray telescope (ATHENA)
  - L3 (2033 launch): to address “the gravitational universe”
    - e.g. space-based gravity wave interferometer (LISA)

(Note: LISA and ATHENA were the two runners-up in L1 competition)

- i.e. no L-class opportunities for Venus before 2035
M-class missions (~500 MEuro)

• M1 (2017 launch) is Solar Orbiter
• M2 (2020 launch) is EUCLID
  – Investigating dark energy / dark matter
• M3 (~2023 launch) downselection to be announced in Feb 2013
  – EChO Exoplanet Characterization Observatory
  – Marco Polo-R Asteroid Sample Return
  – PLATO Exoplanet transits & Astroseismology
  – STE-Quest tests of Einstein’s equivalence principle
  – LOFT X-ray telescope
• M4 mission (~2026? launch)
  – Call for ideas anticipated ~Q2 2014 (TBC)
  – Proposals due ~Q4 2014 (TBC)
M-class mission proposals 2014

‘EVE’ (European Venus Explorer) Cloud-level superpressure balloon
  – 2014 proposal will be broadly similar to 2010 proposal: 1 balloon at 55 km altitude.

A balloon mission in the heart of the habitable layer

• Helium superpressure balloon, 53-57 km float altitude.

• Benefit from benign climate: 10 – 50 °C, atmospheric densities like those found at 0 to 5 km altitude on Earth.

• Explore clouds of liquid water (albeit mixed with sulphuric acid).

• Use high winds of 200-250 km/h to circumnavigate the planet in 5-8 days.
M-class mission proposals 2014

‘Envision’ Venus Orbiter proposal

- See M3 Envision proposal by Ghail et al (described at doi:10.1007/s10686-011-9244-3)
- C-band InSAR based on ESA’s Sentinel-1 radar (launching 2014)
- Atmospheric payload including LIDAR, spectrometers, cameras
- 2014 proposal likely to address same science as 2010 proposal, but with more optimised mission design and wider science team.
M-class mission proposals 2014

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InSAR could allow measurement of surface changes down to cm scale

For Venus, this could provide the most direct possible evidence of active volcanism & tectonism

*Inflation/deflation of Etna volcano, acquired using InSAR*
S-class missions (~50 MEuro)

- ESA contribution of €50m to mission led not by ESA but by another space agency.

- S1 (launch 2017) is CHEOPS
  - (CHaracterizing ExOPlanet Satellite using ultrahigh precision photometry of exoplanetary transits)
  - led by Swiss Space Office.

- No formal date set for S2 at present
Missions of Opportunity

• Finally in the Cosmic Vision stable of missions is one “mission of opportunity”

SPICA (Space Infrared Telescope for Cosmology and Astrophysics)
• Led by JAXA, launch planned for 2022
• ESA contributes the major instrument: 30-210 μm imaging spectrograph
• ESA’s contribution is of the order of €200M

A potential ESA-CAS mission is being considered.
– 25-26 Feb 2014: 1st Workshop in China
– Q3 2014: 2nd Workshop in Europe
– ESA contribution is likely to be S-class, i.e. €50m contribution to a larger mission
– I plan to submit a paper on Venus exploration (abstracts due 16 Dec)
In principle, we could follow the MoO option for ESA participation in Russian-led Venus mission.

- For example, reuse of ExoMars TGO spacecraft (funded by ESA, built by European industry, launched by Russia) would give great science at Venus.
- Possibilities being investigated with Russian partners.
- Note that ESA’s time horizon is long, e.g. typically launch dates 10+ years ahead. This generally precludes major ESA participation in NASA Discovery-class missions.
In conclusion

• M-class mission proposals 2014: coming soon!

EVE – Wilson et al.

EnVision – Ghail et al.