



Future exploration of the ice giants

Scientific discussion meeting
Part of the Royal Society scientific programme

Organised by Dr Leigh Fletcher, Dr Adam Masters,
Dr Athena Coustenis, Dr Kathleen Mandt, Dr Ian Cohen,
Dr Christopher Arridge and Dr Amy Simon.

20 – 21 January 2020

The Royal Society
6 – 9 Carlton House Terrace, London, SW1Y 5AG

Find out more at royalsociety.org/events/for-scientists

Summary of the Ice Giants 2020 Workshop

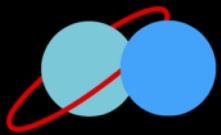
For the OPAG Meeting, 3-4 February 2020
in Houston, Texas

Mark Hofstadter
(Jet Propulsion Laboratory, California Institute of Technology)

With inputs from

Sushil Atreya
Ian Cohen
Athena Coustenis
Leigh Fletcher
Kathleen Mandt
Adam Masters

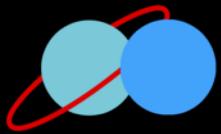
Julie Moses
Olivier Mousis
Amy Simon
Linda Spilker
Tom Spilker
Olivier Witasse



Meeting Background

- Meeting was intended to provide a venue to discuss science, technology, mission design, and strategies for promoting Ice Giant missions.
- Considered holding it at APL, but the prestige of a Royal Society Discussion Meeting won the day.
- There was a concern about early career participation from the U.S.

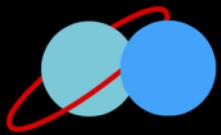




Meeting...ummm...Foreground

- Over 200 attendees, making it the largest Royal Society Discussion Meeting in recent memory.
- 2 days of invited plenary talks at the Royal Society.
- One day of contributed talks in two parallel sessions at the Royal Astronomical Society and Royal Geological Society.
- Posters at all locations.





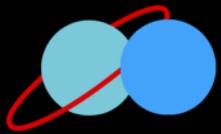
“Standing on the Shoulders of Giants”

William Herschel's notebook from 13 March 1781

* See Fig 1 taken from Flamsteed's Atlas
Collectus
1725

On Tuesday Evening the 13 of March about half after
10 o'Clock I directed my Telescope to one of the four
small stars that form a quartile between the right
foot of Auriga and left foot of Castor, and discovered
near it a star of an appearance very different from
the rest.* With a paler sort of light it had much
more diameter than I thought it shoud have.

At first I suspected some disorder in my telescope; but
finding it in very good order I began to furnish
that this Star might be a Comet. However



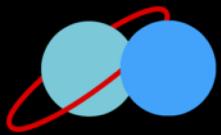
Science Discussions

I do not have the time, nor am I qualified, to review all the topics discussed. Some common discussions were:

- Each Ice Giant system contains an “embarrassment of riches” and is a scientifically compelling target.
- The last decade has seen more Ice Giant papers published than anytime since the Voyager encounters.
- Attendees appreciated the minimization of parallel sessions allowing cross-pollination of ideas between groups that might not normally work together.

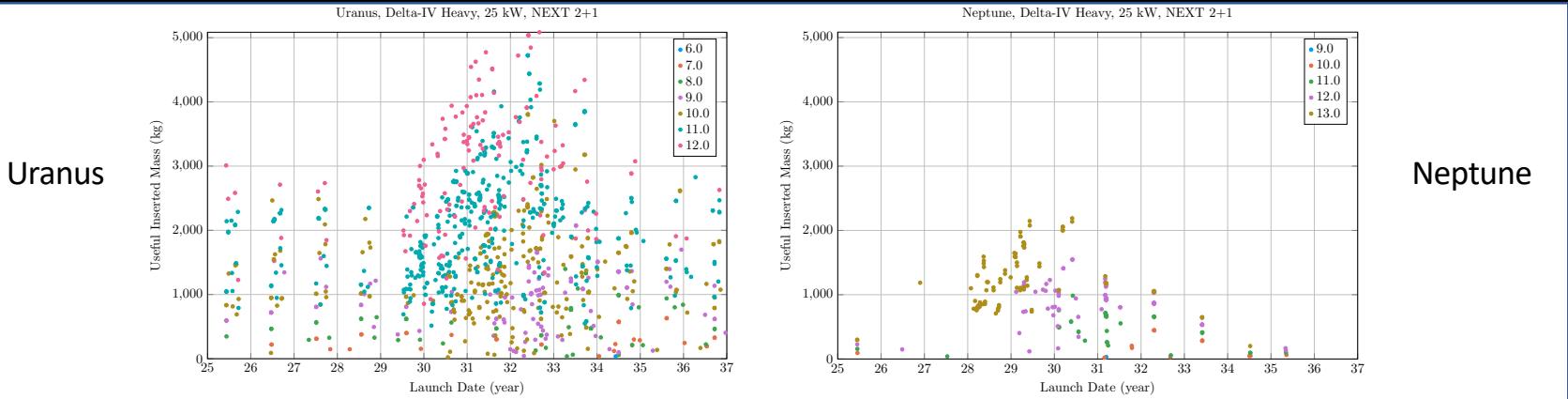
During the question period I can share my favorite science item from each discipline discussed.

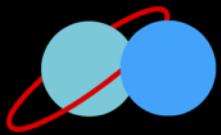




Engineering Highlights

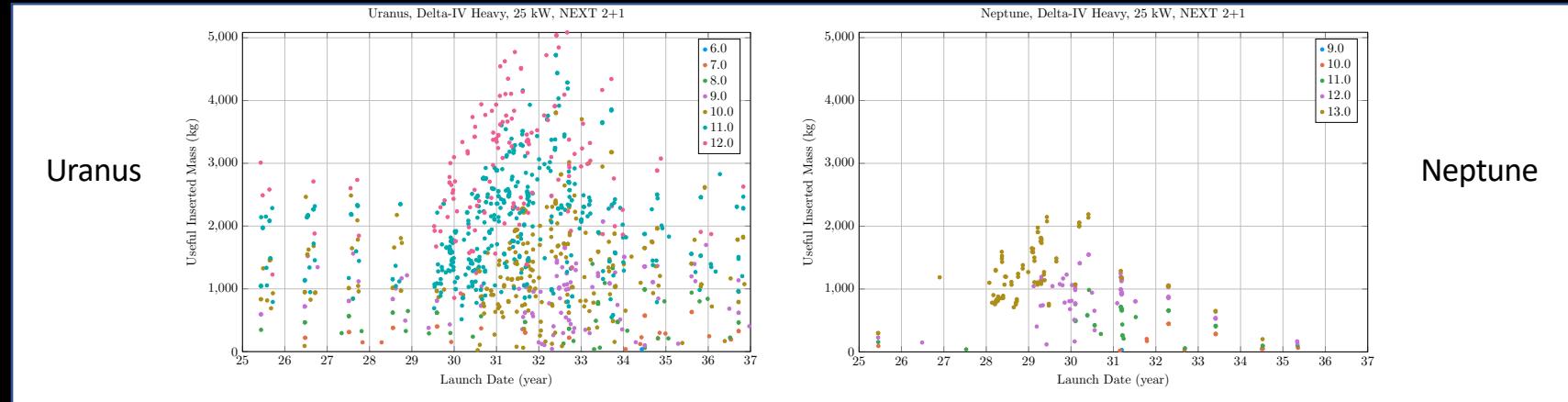
- To send a Flagship orbiter to an Ice Giant with current launch vehicles, you need to launch in 2028-2030 to reach Neptune. Optimal launch windows to Uranus are 2030-2034.
- Neptune is hard to get to.
- If use SLS or other rockets being privately-developed (with upper stages) we may be able to launch to either planet almost any year.

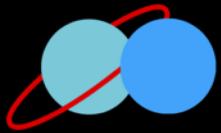




Programmatic Highlight

- For ESA to make a significant contribution (~500 M Euro) to a NASA-led mission, it should launch after 2034.
- Much discussion ensued.....and while there are options to make things work for either Ice Giant, it is clear that Neptune is hard to get to.

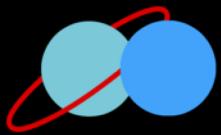




Products of the Ice Giants 2020 Meeting

- Special issue of the Philosophical Transactions of the Royal Society A, covering the science of the Ice Giants and the engineering involved in getting there. (Papers can be submitted from first authors who did not attend, or on topics not discussed.)
- Presentations, recordings, photos will be available on-line (website in transition at this moment).
- Meeting Statement.



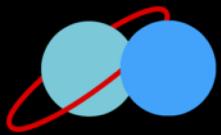


The "Meeting Statement" (1/2)

The organizers have prepared a post-meeting statement, highlighting

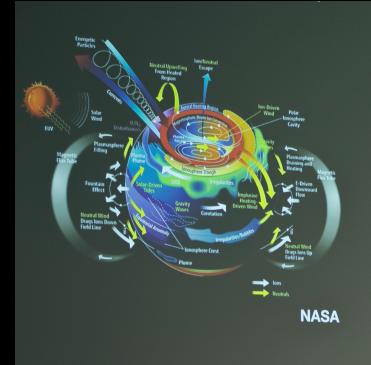
- The cross-disciplinary nature of an IG mission, and the need for a mission “elevator pitch” that captures it.
- Continued European interest in an IG mission, and the importance of advocacy to national agencies.
- Acknowledgment that, based on existing technology, a Uranus mission is more likely than one to Neptune for a joint NASA-ESA effort.





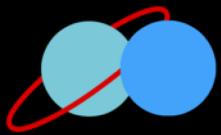
The "Meeting Statement" (2/2)

- The Ice Giant community in all nations should contribute to the U.S. Decadal Survey via White Papers and by serving on committees if asked.
 - It is important to send a clear message: Uranus and Neptune are equally compelling scientifically, and the community will support a mission to either.
 - A concluding note on diversity: It was felt that the meeting had gender and career-stage diversity, but racial diversity was notably lacking.



A portrait of a man with dark hair and a beard. He is wearing a black and white plaid shirt over a light-colored t-shirt. A tattoo of the word "EQUITY" is visible on his left chest. He is looking slightly to his right.

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What Next?

- There are Ice Giant sessions and splinter meetings at upcoming conferences, including LPSC (Monday, 16 March during lunch) and COSPAR (abstracts due 14 February).
- Write Decadal Survey White Papers.

