Student questions: Fran Bagenal colloquium on "NASA's Juno Mission - Extended!"

2/9/22

Fran's responses in blue.

Question 1: What's the reason for Jupiter being the fastest spinning planet on our solar system?

Great Question! I have no idea. Ask a dynamicist.

Question 2: So I now know that Jupiter doesn't fuse any Hydrogen and Helium, but does this means that the planet used to fuse in past?

No. Jupiter is not massive enough that the pressure inside was high enough for fusion. Needs to be about 20 times more massive, I believe.

Question 1: Do storms on Jupiter result in precipitation like on Titan and Earth?

Yes, there's precipitation (ammonia and probably water) but the any material that condenses does not hit a surface (like Titan and Earth). It just re-evaporates as it falls. Like virga rain.

Question 2: If Jupiter's atmospheric dynamics are similar to our ocean's, does this mean they have similar densities? (So you would feel like you're swimming through Jupiter's atmosphere).

I think the densities are not so different – but I think the real issues are the upper and lower boundary conditions as well as the lesser roles of convection & sublimation in driving flows.

Question 1: Could Juno's gravity science instruments be used to study Europa's subsurface ocean when it makes its flyby of the moon later this year?

Juno will certainly try. But I doubt a single flyby will change things much. Needs multiple close flybys of Clipper. Be patient! ;-))

Question 2: Does Ganymede's magnetic field have any significant impact on the structure of Jupiter's magnetic field?

Ganymede's magnetic field is a substantial perturbation locally (and propagating along the fluxtube to Jupiter's ionosphere) but the scale of the Ganymede's magnetosphere is so tiny compared with the giant magnetosphere of Jupiter that it's a pretty small impact globally.

Question 1: Is our equipment able to withstand the massive pressure of the planet, as in, can we get incredibly close to the center?

All the spacecraft we have sent into Jupiter (Galileo probe, Galileo spacecraft) have evaporated pretty close to the surface. I'm doubtful we will see a probe get very deep.

Question 2: How exactly does a strong magnetic dynamo affect the functions of Jupiter (as in, its atmosphere, gravity, etc.)?

There are many ways – the internal flows, interaction (via friction) with the layer above, influencing the aurora and hence heating the atmosphere. Yes, the dynamo flows may be detectable via gravity – stay tuned to Juno observations!

Question 1: Do you think that understanding the background behind Jupiter's Great Red Spot could help to understand/link how the magnetic field of a planet (or other planetary body) interacts or shapes its atmosphere?
Nope. I don't think the GRS is really related to the magnetic field of Jupiter. But I know there are others who think otherwise. Stay tuned!
Question 2: Between Juno and New Horizons, which one has been your favorite, and/or which one has provided you with more "insight" to answer some of the questions that inspire your research topic?
Oh no!! That's not fair!! I love them both!!
New Horizons is telling us exciting new things about new objects – Pluto and KBOs – while Juno is providing new, detailed insights into phenomena that we have had some information about for some time.

Question 1: Why do we speculate on impact theory for the heavy metal core and H mixing?
Ha! Some people just like the idea of invoking impacts to explain everything!
Question 2: Are anomalies in the magnetic field generally associated with turbulent atmospheres of earth-like planetary bodies and gas giants?
Magnetic anomalies are generated in the dynamo deep inside the planet. The time scales for their motions – indicative of the time scales of the interior fluid flows – are many years. So, not really similar to atmospheres.

Question 1: How long will the red spot cyclone continue for?
I have no idea. Current shinkage suggests through the end of the century. What do you think?

Question 1: Would it be possible to use satellite imagery to get a better understanding of gas composition in Jupiter and correlate that work to water in Jupiter's atmosphere?
That is exactly what Jupiter is trying to do with visible, infra-red and microwave measurements.
Question 2: How were the parameters of choosing which gases to measure in Jupiters atmosphere selected?
The wavelength ranges of the instruments were chosen to probe from the cloud tops to deep below the clouds.

Question 1: Does the size of the cyclones in the polar regions show signs of change (i.e., shrinking or expanding), similar to how the size of the GRS is shrinking over time?
The dynamics of the polar regions and the equatorial belts, zones and GRS are different (e.g. coriolis forces play stronger role at equator). So far, over the past 5 years we have seen little change to the polar vortices – they just jostle around.
Question 2: Is the size of Jupiter's magnetic field related solely to the size of the planet, or in part its composition?
Metallic hydrogen is certainly an effective medium for generating a dynamo (e.g. better than ionic water of Uranus & Neptune). Jupiter and Saturn are similar in size – but the factor 3 higher density of Jupiter means it has a larger volume of metallic hydrogen and hence stronger magnetic field than Saturn.

Question 1: Do all planets have a specific Aurora surrounding them?
All planets that have atmospheres have aurora – except Venus. Venus' outer atmosphere is excited by the passing charged particles and solar radiation – but it's not focused in the same way as planets that have magnetic fields (including Mars' crustal magnetic fields).
Question 2: Are there any other planets that closely resemble the same atmosphere Jupiter has?
Saturn is pretty similar – The factor 3 lower mass just means that Saturn's atmosphere is more spread vertically.

Question 1: What does the distribution of water and ammonia around Jupiter and the deep atmosphere as a whole say about the possibility of extraterrestrial microbial life?
I think the possibility of making life in atmospheres is extremely unlikely (sorry Carl Sagan). It's just not dense enough, does not have the special chemical role of liquid water, and keeps moving around and not letting the chemistry happen.
Question 2: Is the search for microbial life being looked into as one of the objectives of the Juno mission?
Nope. What would be signature to look for?

Question 1: Will we be able to place a probe on the surface of our gas giants within my lifetime?
The gas giant planets do not have surfaces.
Question 2: Does nasa hire any artists to help with model building or color correction?
Nope – the artists just do it for fun!

Question 1: What hypotheses have been proposed for the regularity of the circumpolar cyclones observed by Juno?
Here's a paper to read: https://doi.org/10.21203/rs.3.rs-388198/v1
Question 2: Where are the gravitational potential spherical harmonic functions derived from, and how might I learn more about them?
Wikipedia is really good for this sort of thing https://en.wikipedia.org/wiki/Spherical_harmonics

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Question 1: Does the great red spot on Jupiter rotate around the planet as it picks up speed? If so, at what rate?
To first order the GRS rotates with Jupiter's ~10-hour spin period. There are some small year-to-year drifts east and west – pretty irratic.
Question 2: On Earth, our moon controls the tides because of the gravitational pull. Does Jupiter's moon have the same kind of gravity as Earth's moon, and would that cause the wave-like patterns around the planet?
Absolutely. Hard to measure but Juno is working on it.

Question 1: What are you most anticipating on the next Juno flyby?
Next orbit is not particularly spectacular, but in 4 more orbits we will get a really close flyby of Europa that should be pretty cool.
Question 2: Will you drop another probe into Jupiter to try and measure the cloud cover again?
No more probes are planned. The microwave instrument is showing us that scanning with different wavelengths gives us more information about general morphology than a single probe. But perhaps after Juno the atmospheric chemists may have a very specific question that only a probe could answer.

Question 1: How can the data from Juno help us understand the formation of our solar system?
Knowing the abundance of water is pretty important – oxygen is the 3rd most abundant element. Juno is homing in (after dealing with the non-uniformity of the ammonia distribution) on a number for O that is similar to that of the other heavy elements. This means Jupiter formed around an ice core condensing out of the solar nebula.
Question 2: How can we use data from Juno to understand the possibility of finding organics on Europa?
Hummm… that's pretty unlikely. Juno's instruments were designed to look into the atmosphere of Jupiter rather than diagnose composition of ice. Wait for Clipper – it's not so far off!