American Geophysical Union AMA: Hi Reddit, I am Andrew Yau, Editor of Geophysical Research Letters, here to talk about Jupiter and the exciting findings from NASA's Juno mission. Ask Me Anything!

AmGeophysicalU-AMA [1] and r/Science AMAs[1]

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Abstract

I am Andrew Yau, Professor of Physics at University of Calgary, Canada, and Editor of Geophysical Research Letters (GRL), a research journal published by AGU focusing on high-impact scientific advances in all major geoscience disciplines. I am a space scientist. I design satellite instruments such as ion mass spectrometers, and I am interested in the effects of weather in space around the Earth - and other planets. For example, how and why do solar storms cause the heating of the upper atmosphere and its escape into space here on Earth? How about on Venus, Mars, and Jupiter? How does the solar wind produce the aurora, and the associated electrical currents in the ionosphere here on Earth? How about on Jupiter and Saturn, which also have an internal magnetic field? I'll be back at 12 EDT to answer your questions. Ask Me Anything! The AGU AMA series is conducted by the Sharing Science program. Sharing Science: By scientists, for everyone. More at sharingscience.agu.org. Thanks, everyone, for participating in today's AMA. It has been great fun – I hope my answers to your questions have provided a glimpse of the exciting scientific discoveries about the largest planet in our Solar System, Jupiter, from the NASA Juno mission. Some of these discoveries were reported in the recent Special Issue of the Geophysical Research Letters (GRL) for Juno. I encourage you to check out the GRL website for these discoveries as well as some even newer ones that are in the pipeline: http://agupubs.onlinelibrary.wiley.com/hub/issue/10.1002/grl.v44.10/ Sorry I didn't have a chance to field many of the other questions. Have a great day!

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REDDIT

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AMGEOPHYSICALU-AMA R/SCIENCE

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I see you're focused on weather so apologies in advance if this is off topic.

I know on earth we really struggle to get substantial information about the characteristics of rock below even a few centimeters depth without direct physical contact. There's been a lot of technilogical advances in geophysics in the last 10 - 15 years like induced polarization, aeromag surveys, 2D/3D seismic, etc but still nothing can equal a good old-fashioned drill hole. So what tools are available on space missions to gather data on celestial objects' composition? How reliable/accurate are they? To what depth?

Bender-Ender

You are right. A good old-fashioned drill is definitely handy for finding out what is "down there" on other planets that have a solid surface.

Other useful techniques include ground penetrating radar, as well as other "remote sensing" devices such as magnetometers, seismometers, and accelerometers. It is amazing how much reliable and accurate information one can get from these devices based on our knowledge of the underlying

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physics.

For example, an accelerometer measures the instantaneous acceleration or deceleration on a spacecraft at very high precision. The measurements are then used to derive (“back out”) the gravity of the planet using the laws of orbital dynamics, and to infer its physical properties together with other measurements.

By the way, no need to apologize; your question is not off topic at all. While my own research is focused on “space” weather near Earth and other planets, Juno and many other planetary missions are aimed at investigating a wide range of topics including planetology, by necessity and by design.

What is one finding that surprised you the most from the Juno mission?

Bertanx

For a “particle person” like me interested in the energetic charged particle radiation and the aurora on Jupiter, the finding that ions (protons) with hundreds of kilo-electron volts of energy are “shooting” out of the planet is probably the one that surprised me the most. However, a few other findings are almost equally surprising to me. For example, the intensity variations of the ultraviolet aurora on Jupiter do not quite correlate with the fluctuations of the solar wind dynamic pressure. This is totally opposite to our experience here on Earth.

Thanks for doing the AMA! I have two questions if you don't mind:

1. Did the Juno mission live up to your hopes and expectations? Exceed them? How did you keep them in check as you prepared for the mission to take place?
2. What will the next big step for Jupiter research be?

recentfish

You are very welcome!

On your first question: Juno definitely lives up to my hopes and expectations so far. The mission has performed flawlessly to date, including all the instruments, and the data that it has brought back cannot be more amazing, not to mention the several interesting new findings (which are the subject of a number of papers in the recent special issue of Geophysical Research Letters and in Science).

Looking ahead, I am certain that Juno will exceed not only my but also many other people’s expectations, given that many more, new results that will be coming down the pipe.

Actually, I am not part of the Juno mission team or science team, and so was not involved in the mission preparation. To keep my expectations “in check”, my approach in Juno was the same as in missions that I was personally involved in: I hope for the best, and prepare for the worst, by keeping in mind the mission’s capabilities as well as the limitations of these capabilities, and the many “known” unknowns as well as the many “unknown” unknowns.

On your second question: The European Space Agency is leading the Jupiter Icy Moons Explorer (JUICE) mission, which is a mission to Ganymede and the Jupiter system in collaboration with NASA, for planned arrival at Jupiter in 2030.

I would say JUICE is probably the next big step for Jupiter research. However, a lot of exciting new things might (and likely will) come out of Juno and various Earth-based observatories (e.g. the Nançay Decimeter Radio Telescope in France), and evolve into the "next big step" in the meantime.

What are some very cool facts or amazing pictures from the recent Jupiter and Saturn missions that I can tell/show to a three years old girl who is very into planets and space?

toiletpapermonster

Hmmm… I recall my daughter barely able to spell Jupiter and Saturn when she was three years old. Be that as it may, NASA's Juno mission website (https://www.nasa.gov/mission_pages/juno/overview/index.html ; see also https://www.nasa.gov/mission_pages/juno/images/index.html) has quite a number of images and videos for Jupiter that might work. See also https://www.nasa.gov/jupiter for some cool facts on Jupiter.

For Saturn, some of the best images can be found on the NASA/JPL Cassini mission and the Hubble Space Telescope websites https://saturn.jpl.nasa.gov/galleries/images/ http://hubblesite.org/images/gallery

Three-year-old girls - and boys - are pretty smart these days, so hopefully you will find the pictures and info in the above sites useful.

I'm studying geology as an undergraduate, also at a University in Alberta! What can I do to get involved with space research?

SchroederMeister

I would start by learning about all the exciting space research that is going on right at your doorstep at University of Alberta, in various space science areas: from near-Earth space environment, to planetary magnetosphere, to planetology, to meteors, asteroids and near-Earth objects (NEO).

As you know, U of A has several world-leading researchers in these areas, for example Professors Ian Mann, Robert Rankin, and Christopher Herd, to name just a few. I would try to "knock on their doors" for advice and guidance. (You probably already know about the recently launched cubesat built by U of A students and led by Prof. Mann's group.)

I am sure you will not be disappointed.

Hi there! I am pursuing a major in geophysics here at MS&T. My question is how did you get into the field of being a space scientist? Where did you start at, and how have you gotten to this point in your career with a geophysics degree? I am very interested to know because this all sounds like exactly what I would love to do. Thanks!!!

nooneisnothere

Good for you! I started as a summer research student at Harvard College Observatory in Cambridge, MA, back in 1975, where I learned about and assisted in upper atmospheric research with NASA's Atmospheric Explorer (AE) mission at that time. I then took a grad course "on the side," on the upper atmosphere and ionosphere, at York University in Toronto, Canada, and subsequently joined the Space Physics Group at the Herzberg Institute of Astrophysics in Ottawa, Canada to pursue postdoctoral research in auroral plasma physics.

I have gotten to this point in my career, with a lot of help along the way from many people who love what they do as much as I (and generously give me the opportunity when I need one). If space science is also what you love to do, that's great. I say go for it, whether it is in geophysics or other space

physics areas.

What would happen if I lit a match while falling into Jupiter?

Temp1493

You would immediately think of the Hindenburg - just kidding; you won't have time to. As you know, the Jupiter atmosphere is composed of about 75% hydrogen, which would ignite instantly.

Not a good scenario to envisage on a sunny Monday morning...

Hi Andrew.

Do you think it's easier to be a scientist in Canada or America? Most people I know in the field get annoyed by the incredible amount of paperwork they must do to get/keep funding instead of performing work in the actual field and progressing the knowledge of the community.

zared619

I think this depends in part on what science one wants to do. Also, the overall funding climate for science in both Canada and the US tends to change with time, being more favorable in Canada at some times, and less so at others.

It is also difficult to compare the Canadian apple with the American orange when it comes to research funding, when you consider that the US spends more than ten times per capita in space science research than Canada, for example. (This does not include spending under DoD's Space Program.)

It is true that as the funding system becomes more competitive, and the granting agencies increasingly emphasize "performance" instead of actual scientific productivity in the name of accountability and "return of (taxpayers') investment", the amount of paperwork increases exponentially, not to mention researchers' frustration on both sides of the border. Fortunately, scientists in both Canada and the US have been quite "resilient" in continuing to do their best despite the circumstance.