

# Inside Jupiter

Juno to enter planet's orbit July 4

By Mark Whalen

Though the largest planet in the solar system and the target of previous missions, Jupiter still holds many mysteries. What's beneath the clouds? Does the planet have a dense core at its center, or is it hydrogen and helium atmosphere all the way down?

A new mission will go where others have not yet ventured. When the Juno spacecraft enters orbit around Jupiter on July 4, it will offer views of the planet unlike any previously achieved—and will be well-posed to settle long-standing questions about the planet and the solar system.

Juno—designed and built by Lockheed Martin Space Systems in Denver, which also handles day-to-day operations—will perform a main-engine burn on Independence Day to begin its 20-month odyssey of new discovery.

"It's important to remember that while this is a critical milestone for the project, it is really a gateway to our unprecedented close-up study of Jupiter," said Project Manager Rick Nybakken.

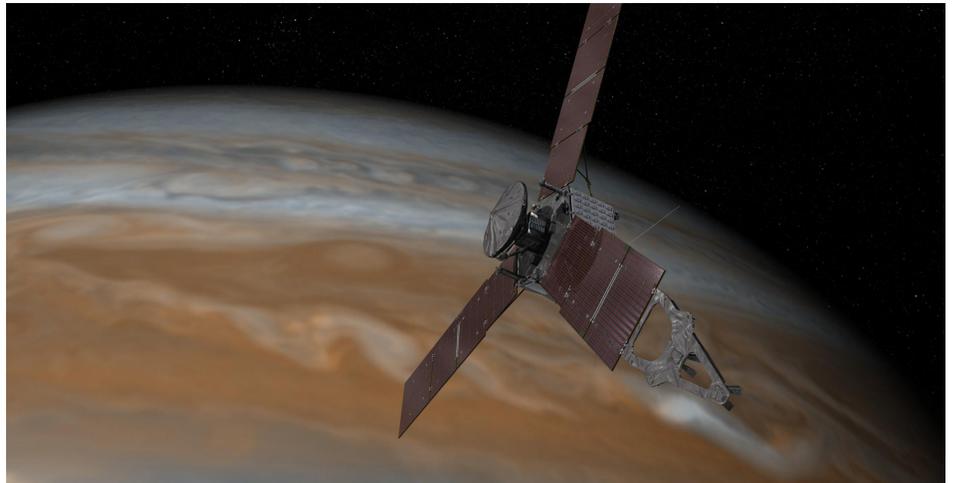
Former JPL employee Scott Bolton, now with the South West Research Institute, is Juno's principal investigator. Bolton, along with the late JPL project manager Rick Grammier, organized the proposal and development team for Juno.

One of the tasks for Project Scientist Steve Levin has been as a liaison between the engineering and science teams, serving as Bolton's "eyes and ears" at JPL.

Levin is most looking forward to Aug. 27, when the spacecraft completes its second perijove pass—the point in the orbit that is closest to the planet—and all of the science instruments are turned on for the first time. "For me, that's the exciting day," he said.

The spacecraft will reach its first science orbits in mid-November, when the main engine is fired one last time to enter its 14-day science orbit.

Juno's goals will differ markedly from that



of Galileo—which as one of JPL's historically successful flagship missions provided an unmatched wealth of discoveries and science findings of the Jupiter system—particularly its mysterious rings and moons.

Juno will perform a close-up study of Jupiter, but this time, due to planetary protection policies, will do everything possible to avoid the planet's moons. Juno's polar orbit will take it repeatedly within 3,000 miles of Jupiter's cloud-tops, operating closer to the planet than any previous mission.

In addition to encountering potentially dangerous magnetic fields and charged particles, a major challenge for the mission is operating in Jupiter's radiation environment, which can wreak havoc on the spacecraft, its electronics and its instruments.

"We pay attention not only to accumulation of radiation, but every time you fly close to Jupiter there is short-term exposure that could be disruptive," noted Nybakken. "We've thought a lot about the environmental risks and how to mitigate them—both in the pre-launch design and testing as well as in how we operate the spacecraft."

Levin noted that Galileo and its Huygens probe found little water at Jupiter. He expects Juno to find more by measuring for it in a completely different way. "We think we can

get the global water abundance with much better measurements than we could do with a single probe," he said.

Juno will deploy a microwave receiver with six channels that can see different depths through the atmosphere, much deeper than the probe could go, said Levin. The receiver will see the atmosphere not just in a single spot but across the planet, over a wide range of angles. How deep the channels see depends on the amount of water observed.

There are lots of mysteries about Jupiter, and in many ways they tie in to our understanding of how planets in the solar system formed, noted Levin.

"Jupiter, by itself, is more than two-thirds the planetary mass of the solar system—and it formed first. Its gravity will have affected the formation of all the other planets," he said. "What's left for Earth depends in part on how Jupiter formed—how and where Earth formed depends on how and where Jupiter formed.

"We're doing other science, of course, but the key things we're looking for are the origin of Jupiter, the interior, how the massive atmosphere and dynamics work, the magnetosphere, the aurora, the northern/

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# Looking back

By Franklin O'Donnell

Elachi reflects on his 15 years leading JPL

*Charles Elachi will wrap up his 15 years as JPL's director at the end of June when he moves to the Caltech campus to continue his research. Elachi recently sat down to reflect on his tenure leading the Lab.*

## When you took the job as JPL's director, what did you want to accomplish?

When I became director in 2001, it was fairly soon after we had the losses of Mars Polar Lander and Mars Climate Orbiter. My first priority was to improve the morale and ensure JPL maintained its leadership position.

As I talked to the national leadership in Washington, particularly on the Hill, they said, "Don't shy away from challenging things. We want JPL to continue pushing the frontier, to really do the kind of things that only JPL can do."

I had some specific objectives. One was to make the Spirit and Opportunity Mars rovers, which then were just starting in development, a steppingstone toward a long-term, continuous presence on Mars, leading to sample return.

Another major objective was Europa. There was excitement building about Europa, based on the Galileo mission's observations. One key goal was to establish a commitment to explore Europa and what has now become known as the Ocean Worlds initiative.

Another goal involved the whole area of detection of planets around neighboring stars. I believed that the search for exoplanets, especially the exciting idea of perhaps one day finding signatures of life



Photo by Josh Krohn / JPL Photo Lab

on another exoplanet, was something JPL had to pursue.

Earth science was very important. That was a large part of my early experience at JPL, and I wanted us to become a major player in this area. We were already a player, but we were not yet one of *the* major players.

Then there were the internal objectives—lifting the morale, making JPL an exciting place where everyone would want to come and work. So—anticipating your next question—I'm happy to say that, looking back, I'm delighted that all of these have been accomplished. So I am moving on feeling really good about all that we have accomplished.

I want to emphasize that all these achievements are the result of our team effort. I was blessed to have a superb Executive Council. I was blessed to have the kind of talent we have at JPL. You've heard me say many times every single person at the Lab plays an important role

in achieving our objectives: the engineer, the scientist, our business and public engagement professional.

## What stands out in your mind as the high points from your time as JPL director?

Well, every time a mission makes a new discovery is a high point. Beyond that, there are events that are certainly dramatic points—the landings of Spirit, Opportunity and Curiosity, Cassini going into orbit around Saturn. When we discovered geysers on Europa or took the first picture of the lakes and the rivers on Titan, those were exciting moments. The same was true of when we first measured carbon dioxide in Earth's atmosphere, or the first time we detected a planet around another star that had characteristics similar to Earth. Whenever we take a new measurement that increases our understanding in some way, I am proud.

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**Conversely, are there any low points that you are happy to have gotten through?**

Well, this might take people by surprise. I really didn't have what I consider low points. I mean, there were tough decisions to be made and challenges to be made. One, clearly, was when we had to delay the Curiosity mission by two years. It was a very tough call, but the right call. When the Genesis spacecraft returned to Earth and its parachute did not open, that was also a very challenging time. But in the exploration business there are challenges. You have to accept that is part of the job. Besides, we are here to push the limit by taking calculated risks. And when you take a risk, there will be at times setbacks. Otherwise it's not a risk.

**Obviously across those years there have been a lot of amazing accomplishments. Is there anything that stands out in your mind as one you're particularly proud of?**

That's always dangerous. That's like asking, "Out of your two daughters, which one do you like more?" (*Laughs.*) There is no one specific thing, but many things we can be proud of. We've had continuous presence on the surface of Mars for 12 years. We have a spacecraft that has been exploring Saturn for the last dozen years. We brought samples back to Earth from the tail of a comet. We have established with absolute proof that sea level on Earth is rising. We have identified thousands of asteroids. And 2,300 planets have been detected beyond our solar system.

There are other things I'm very proud of, not mission-related but still very important. When I became director I worked with Dan Goldin, who was then the NASA administrator, to establish a commitment for ongoing funding for research and

## **"It's hard to describe to people how exciting it is to lead an organization like JPL, and what a source of pride it is."**

JPL Director Charles Elachi

technology development. This is critically important—it is our way of investing in areas that will pay off in the future, developing capabilities that didn't exist before.

The other thing I'm proud of is the social events we've had that bring together JPL employees. Here I want to give credit to my wife, Valerie, because it was her idea that we really needed to create more of a family feeling.

Besides the things I'm proud of, there are also things for which I feel very fortunate. I was fortunate to work with three presidents at Caltech—David Baltimore, Jean-Lou Chameau and now Tom Rosenbaum—and all three of them have been amazing supporters of JPL. I have served under four NASA administrators—Dan Goldin, Sean O'Keefe, Michael Griffin and now Charlie Bolden—and I enjoyed working with all four of them. All four of them have treated JPL as part of the NASA family, and have expressed real appreciation for the things that JPL has accomplished.

**What do you see for JPL when you look at the future?**

I believe the years ahead will be as exciting as the recent past. There will be exploration of Europa with an orbiter and lander, Mars missions preparing for sample return. In astronomy there is development of a coronagraph on the WFIRST observatory, and starshade technology that will enable us to actually image neighboring solar systems. In Earth science there will be advances in our ability to study the water cycle or the carbon dioxide cycle or the changes in

the ocean.

And these things don't just happen. We get this work because we do it the old-fashioned way: we earn it. It's because of our successes, because of the new ideas that JPL brings to the table, that's what makes the future so exciting.

**What are your plans now?**

I'm not handing in my JPL badge. That's for sure. I'm looking forward to continue doing research on JPL missions, be it Europa or Cassini—basically the missions that involve radar. I intend to be a strong advocate of the space program. I believe it's essential for the nation's spirit but also for opportunities for our next generation. Beyond that, I'll be doing a lot of traveling and hiking. I'm certainly looking forward to spending more time with my two grandkids. And then there is that long list of honey-do jobs my wife has waiting for me to tackle. I'm not going to want for things to do.

**Is there anything you will miss the most when you think back?**

What any director of JPL would miss is the excitement of being here. It's hard to describe to people how exciting it is to lead an organization like JPL, and what a source of pride it is to do that.

And I can assure you that, when all of you retire, you will miss coming every day to the exciting place that JPL is.

But I'm thankful for all my years here. I wouldn't change a single day from what I have done. And I'll be watching you guys and cheering for you.

**Note: This is an abridged version of the interview. The full text is available on JPL Space, <https://js.jpl.nasa.gov>**



Photos by Josh Krohn / JPL Photo Lab

Many guests enjoyed getting a feeling for the prototype rover.

# A Ticket to Explore

By Mark Whalen

More than 20,000 visitors came to the Lab Saturday and Sunday, June 4 and 5, for “A Ticket to Explore JPL,” the Lab’s experiment that replaced its traditional open house with a ticketed event.

Designed to address issues with traffic, parking and crowding at recent JPL open houses, the weekend won high praise from

public visitors.

“The new system works wonders. Awesome job @NASAJPL. Ticketing was a huge success. Fast and easy :),” noted one online comment. “Thanks for #ExploreJPL! It was a treat for the whole family. My 15-year-old daughter saw just how cool science

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JPL welcomed more than 20,000 visitors over the two-day weekend.



Clockwise, from top left: a young visitor sees the astronauts' point of view; a crowd is intrigued by RoboSimian, the JPL-developed ape-like robot; overlooking the clean room; an anxious group waits to enter the Space Flight Operations Facility.

## A TICKET TO EXPLORE *Continued from page 4*

can be," said another.

Free tickets were distributed online in April. Overall, JPL received about 150,000 requests for tickets; 15,000 were made available for both Saturday and Sunday.

Deputy Director for Communications and Education Stephen Kulczycki said about 9,500 attended on Saturday, with about 10,500 Sunday. Tickets permitted staggered arrival times, with the latest entry at 1 p.m.

JPL social media posts indicated that more tickets became available Sunday and were issued via the same online signup.

"We are collecting as much data as we can for the benefit of future events," said Kulczycki.

"I'd like to take this opportunity to thank everyone who gave up weekend time to bring the excitement of our work to the public at large," said JPL Director Charles Elachi in a memo to employees. "Inspiring the public is a vital part of our mission, and there's no doubt 20,000 people went away with enthusiasm and pride for all we do to support our nation's space program."

Tweets, Instagram and Flickr posts on the event are shown at [storify.com/VeronicaMcG/explore-jpl-sunday](https://storify.com/VeronicaMcG/explore-jpl-sunday). ■

# News Briefs

## Innovative concepts funded

Four studies led by JPL were recently selected for funding through NASA's Innovative Advanced Concepts Program.

JPL won four of 13 competed nationwide awards. No other organization won more than one (the rest of NASA combined won two) award in the competition that was open to any organization or individual.

The JPL winning principal investigators and their studies are:

Ratnakumar Bugga, for *Venus Interior Probe Using In-situ Power and Propulsion*; Masahiro Ono, for *Journey to the Center of Icy Moons*; Marco Quadrelli for *E-Glider: Active Electrostatic Flight for Airless Body Exploration*; and Jonathan Sauder for *Automaton Rover for Extreme Environments*.

## Benardi honored at White House

At a White House ceremony in May, JPL planetary protection engineer James Benardini received the President's Early Career Award for Scientists and Engineers.

Six of the 106 awards bestowed went to NASA employees. Benardini's honor was for "outstanding innovation and leadership across the breadth of the planetary protection discipline, spanning both research and flight project implementation."

## Passings

JPL engineer Greg Hickey, 54, died May 15.

During a 30-year JPL career, Hickey managed or contributed to projects on Mars rovers, space telescopes, composite materials, robotics and advanced optical research. He managed JPL's Advanced Optical Systems Program.

Hickey's first wife, Denise, preceded him in death. He is survived by wife Patricia, son Patrick, daughter Kristina, and grandchildren Dianna and Isabelle. Services were held May 25 in North Hollywood.



Greg Hickey



Thom Wynne / JPL Photo Lab

At a JPL ceremony, Virendra Sarohia, third from left, is joined by his wife, Venita, JPL Director Charles Elachi (left) and Deputy Director Larry James.

## French ministry honors Sarohia

JPL researcher Virendra Sarohia, technical assistant to the chief technologist, has been awarded the Palmes Académiques, the highest accolade bestowed by France's Ministry of Education.

The award is for Sarohia's efforts in furthering international cooperation, particularly with France.

Sarohia joined JPL in 1975 as a member of the technical staff after receiving his Ph.D. in aeronautics from Caltech. He has been the JPL/Caltech-NASA liaison officer since 2004 and has been instrumental in strengthening ties between the French space agency Centre National d'Etudes Spatiales and JPL.

## Letters

I would like to thank members of the MGSS management team and Section 394 staff for your condolences on the passing of my brother, Mark Elias Estefan. Your kind words, cards and the lovely Dracaena house plant were very much appreciated by our family. Mark had a real affinity for all things related to space and space exploration and he will be sorely missed.

**Jeff Estefan**

Thank you to all my friends here at JPL for your condolences on the passing of my mother, Hajira Ahmed. The plant and the card were very thoughtful. My family and I very much appreciate the comforting kind words we have received. My mother lived locally for 20 years and was an integral part of our daily life. She will be dearly missed. Thank you all.

**Nagin Cox**

To my friends in Section 312 and around the Laboratory, my deepest thanks for your support and kind words on the passing of my life's companion, Patricia Griffith. You have made a difficult time a little easier.

**Scott Burleigh**

I would like to sincerely thank my co-workers and the JPL community for their kind expression of sympathy in the recent passing of my mother. The condolences were comforting and greatly appreciated. The lovely JPL plant is most symbolic at this difficult time.

**Ellen M. Walsh**

## JUNO *Continued from page 1*

southern lights."

Juno's microwave radiometer, gravity science measurement and magnetometer are the big three of its nine-instrument suite. One of them, JunoCam, has its own public outreach website (<http://missionjuno.com>)—which will be used mostly by amateur astronomers—and is already receiving uploaded telescopic images of Jupiter from members of the public. The website allows the public to not only view, discuss and vote on submitted images but also to propose future targets for JunoCam to image.

Although Juno will steer clear of Europa, the mission's experiences could help on a future pathway to the icy moon, which NASA plans to explore for habitability in the 2020s.

"We will learn about the radiation environment because we're in it," said Levin, also a member of the Europa mission radiation advisory board. "It's not a straightforward, one-to-one correspondence, but it should help with the radiation models for Europa. What we learn with Juno is relevant to what the Europa mission will do."

A NASA New Frontiers Program mission launched in August 2011, Juno will achieve 37 orbits of Jupiter, with the end of the mission planned as a deorbit into the planet in February 2018. For more information, please visit <http://www.jpl.nasa.gov/missions/juno>.

# Classifieds

Ads submitted May 25 to June 3. To submit an ad, e-mail [universe@jpl.nasa.gov](mailto:universe@jpl.nasa.gov).

## For Sale

**BIKE**, awesome 20" Schwinn; we bought it a year ago for our son but he has outgrown it, about four months ago we had Sport Chalet add new inner tubes and anti-puncture liners in each tire, bike is hardly used and in great shape, your son or daughter will love it, \$50. [Leticia.1dcs@yahoo.com](mailto:Leticia.1dcs@yahoo.com).

**MISC.**: Mini steam iron, Rollerblades (men's 8), Bloody Mary set, stemless decanter set, board games, woman's M "Galileo Fit. Team Mbr" LS red turtleneck. 818-272-3262 for photos.

## Vehicles / Accessories

'04 FORD Taurus, V6, green, leather interior, a/c, cruise control, CD changer, 105,000 miles, one-owner car, Ford dealer service history, very clean, excellent condition, recent new tires and brakes, \$2,500, 626-390-6951, [jimcobb@gmail.com](mailto:jimcobb@gmail.com)

'00 HONDA Accord LX, 2000 cc 4-cylinders, 5-speed manual transmission, green, 196,000 miles, runs great, engine in excellent condition, \$1,500. 818-203-7639.

'09 SUZUKI Boulevard M50 Cruiser, 5 yrs. old, 800 cc, only 7,600 miles, Indian red color, exc. cond., never drop, no accident, \$3,800. 818-203-7639.

'99 YAMAHA Virago 1100 motorcycle, one owner, 39,150 miles, excellent condition, recent tune-up, includes one spare fuel tank (slightly dented but usable), \$1,800. 626-358-8941.

## Wanted

SPACE INFO/memorabilia from U.S. & other countries, past & present, for personal use (see <http://www.youtube.com/watch?v=S7PvjGp7mCU>). [mrayman@alumni.princeton.edu](mailto:mrayman@alumni.princeton.edu), 818-790-8523, Marc Rayman.

UPRIGHT BASS CASE, hard, ¾ size, for air travel. 818-437-3513, Susan.

## Real Estate for Sale

LEBEC-area mountaintop retreat, spectacular views, 4 br./2 ba., 3,210 sq. ft. custom-built house on 20 acres, surrounded by vast fields of wildflowers in spring, but stunning year-round; only about an hour from JPL north on I-5; includes spacious workshop or artist's studio; see <http://www.tourfactory.com/idxr1308594>; \$574,900. 805-358-1626 or [Robert.A.Preston@icloud.com](mailto:Robert.A.Preston@icloud.com).

## For Rent

ALTADENA, bedroom in large 3 bd / 2 bath house, can be furnished if desired; 2 miles to JPL, shared common areas with 31-yr.-old JPL engineer; lg., open kitchen w/updated stainless appliances, lg. living & family rooms, washer/dryer, well-appointed backyard entertaining area, lg. driveway; finished garage offers hobby/storage space, additional bathrm. and kitchenette; all utilities and 50+ Mbps internet included; \$960/month + \$900 deposit. 626-524-3972 or [bmarti@rocketmail.com](mailto:bmarti@rocketmail.com).

ALTADENA foothills home, comprehensively furnished for extended stays: 2 bedrms., guest room + office; 3 miles/JPL, view; fireplace, oak floors,

antiques, fine furniture, beds, dinnerware, starter kitchen supplies, linens, towels & most necessities included, just bring toothbrush & clothes; TV/DVD/Dish satellite, wireless DSL; garden, fruit trees, all organic; secluded, quiet, safe neighborhood near trails. 626-798-3235, [gaboon@sbcglobal.net](mailto:gaboon@sbcglobal.net).

ALTADENA (91001), furn. loft w/awesome view for lease; non-smoker to share a beautiful 4-bedroom, 3-bath house across from community garden; close to local colleges, route to Kaplan, Pasadena schools, walking distance to JPL; utilities included, central air/heat, internet access; near 210/134/110 frwys./bus stop/shopping/bank/entertainment/restaurants; \$700/mo. 818-370-0601.

GLENDALE, 7 miles from JPL, home has cathedral ceilings, arches, 2 fireplaces, tile/hardwood flooring throughout w/a wraparound balcony, perfect for entertaining; baths: 2 full, 1 half; laundry in unit; attached garage parking; central cooling, forced-air heat; see [http://www.zillow.com/homedetails/3290-Beaudry-Ter-Glendale-CA-91208/20820631\\_zpid](http://www.zillow.com/homedetails/3290-Beaudry-Ter-Glendale-CA-91208/20820631_zpid); \$5,100/mo. 323-810-8938.

HIGHLAND PARK, fully furnished cool and cozy cottage in one of LA's hippest neighborhoods; super-private, quiet, close to all hot spots (great restaurants, bars, coffee shops, galleries, etc.) on York Blvd., light rail nearby to whisk you all over LA without having to drive; 1- to 6-month rental, \$1,750/month, utilities included. 323-481-3262.

PASADENA, 2 furn. rooms in a lovely 4-bd./2-bath house, big backyard, hardwood floor, big closet, shared bathrm., kitchen/laundry privileges; 2 miles to JPL, close to public transport; short- or long-term lease avail.; must like dogs and be very clean; \$800 and \$850 + \$800 deposit. 818-960-8654.

## Vacation Rentals

BALBOA ISLAND, 2 bedrooms, 1 bath, deck with BBQ, sleeps 5, remodeled in 2010, walking dist. to main street restaurants, shopping, bay and ocean; special weekly rates for JPLers. [Bettyrs@earthlink.net](mailto:Bettyrs@earthlink.net) or 626-429-3677.

JACKSON HOLE, WY: Luxurious bed and breakfast on 3 acres of solitude on Snake River near Jackson Hole Mountain Resort and south entrance to Grand Teton Natl. Park; see <http://www.bentwoodinn.com/>; mention JPL for discount. [info@bentwoodinn.com](mailto:info@bentwoodinn.com), 307-739-1411.

MAMMOTH, Snowcreek, 2 bd., 2 ba. + loft, sleeps 6-8, fully equip'd kitchen incl. microwave, D/W, cable TV, VCR, phone, balcony w/mtn. vw., Jacz., sauna, streams, fishponds, close to Mammoth Creek, JPL discount, no pets. 626-798-9222, 626-794-0455 or [valeriee@caltech.edu](mailto:valeriee@caltech.edu).

MAMMOTH, Snowcreek, beautiful updated condo, 2 bd., 2 ba. + loft (sleeps 6-8), great location by pond/meadow, new appliances, TVs, DVD players, free wireless Internet and washer/dryer, no pets. 818-952-2696 or [BigMtnPrettySky@gmail.com](mailto:BigMtnPrettySky@gmail.com).

MAMMOTH, remodeled 2 bed/2 bath + loft, short walk to Canyon Lodge; Courchevel 6 features full kitchen, cable and Internet TV, DVD & Blu-Ray, wireless high-speed Internet, 2-car garage, Jacuzzi, summertime grill and pool; no pets. <http://Courchevel6.com>.

MEXICO (1 bedrm.): Mayan Palace: Acapulco, Nuevo Vallarta, Riviera Maya, Puerto Vallarta; Sea Garden: Acapulco, Nuevo Vallarta, Mazatlan; trades available with II and RCI based on availability. 818-272-3262.



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# Universe

## Editor

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