Astronomy

The importance of being Jupiter

If stars other than the sun have planets, those orbiting bodies probably don't match Jupiter and Saturn in size and composition. In fact, even if rocky, terrestrial planets akin to Mars or Venus prove abundant, Jupiterlike gas giants may well be rarities. A new report lends support to that intriguing notion.

Scientists have long argued that the planets in our solar system formed from a disk of gas and dust that surrounded the nascent sun. Because Jupiter and Saturn have massive atmospheres of helium and hydrogen, they must have captured these gases gravitationally from the solar disk.

That may pose a problem. The vicinity of ordinary, sunlike stars has little gas, suggesting that hydrogen and helium aren't easily retained in orbit as these stars mature. For example, the solar system now contains only a few percent of the hydrogen and helium needed to make Jupiter and Saturn. Thus, the planets must have formed rapidly (SN: 3/27/93, p.198).

It's possible that the sun's environs once contained much more hydrogen and helium. But according to George W. Wetherill of the Carnegie Institution of Washington (D.C.), a middle-aged, stable star like the sun of today couldn't have blown away such large quantities of gas recently. However, the sun might have done so during its turbulent first few million years. If so, the gas giants Jupiter and Saturn must have grabbed their helium and hydrogen early.

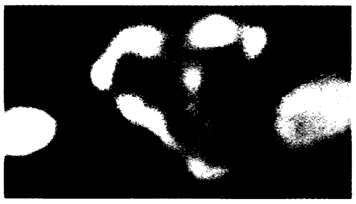
Astronomers can't turn back the clock to find out how much hydrogen the infant solar system contained. But by examining the amount of this gas around young, sunlike stars, they can attempt to determine whether these stars possess the raw materials needed to make Jupiters and Saturns.

In their study, Ben M. Zuckerman of the University of California, Los Angeles, Thierry Forveille of Grenoble Observatory in France, and Joel H. Kastner of the Massachusetts Institute of Technology examined 20 nearby, sunlike stars with estimated ages of between 1 and 10 million years — presumably young enough that they would not yet have blown hydrogen and helium out of their vicinity. Using the 30-meter IRAM radio telescope in Pico Veleta, Spain, the group inferred the density of molecular hydrogen. Because this molecule doesn't emit radio waves, the team measured the abundance of carbon monoxide, which exists around sunlike stars in a specific ratio to hydrogen.

The team reports in the Feb. 9 NATURE that even stars just a few million years old typically have much less molecular hydrogen than the mass of Jupiter in their environs. "Thus, if gas-giant planets are common in the galaxy, they must form even more quickly than present models suggest," the researchers conclude; more likely, the planets have only a small chance of forming.

In a commentary accompanying the report, Wetherill speculates that the existence of Jupiter and Saturn in our own planetary system could be a statistical fluke. He adds, however, that these planets serve to protect Earth, deflecting or ejecting comets that might otherwise bombard our planet. Without Jupiter and Saturn, Earth might not contain life to ponder the existence of these giants.

A valentine from Jupiter



D. Gilmore, K. Noll/Space Telescope Sci. Inst.

Sorting through Hubble Space Telescope images taken soon after Comet Shoemaker-Levy 9 crashed into Jupiter, researchers were heartened to find this feature in the Jovian cloud tops.

Technology

A computer eyes the heavens

Like wine tasters with world-class palates, astronomers trained in the art of classifying galaxies by shape can scarcely keep up with the demand for their services.

To distinguish elliptical galaxies from spirals and the myriad shapes in between requires years of tedious practice. A glut of astronomical data has overwhelmed the few experts capable of such "morphological" classification.

To help with this problem, Ofer Lahav of the Institute of Astronomy in Cambridge, England, and a team of astronomers and computer scientists have trained a computerized electronic eye in the subtleties of galaxy classification.

"The challenge is to design a computer algorithm that will reproduce classification to the same degree that a student or colleague of the human expert can," the authors explain in the Feb. 10 SCIENCE. For their test system, they chose an artificial neural network. Originally suggested as simplified models of the human brain, such networks "are computer algorithms that provide a convenient general purpose framework for classification."

The automated procedure involves two steps. First the system extracts key features, such as a galaxy's color or number of spiral arms, from a digitized image. Then it fits those features into a classification, based on a "training set" of images organized by a panel of astronomers.

Overall, the neural network proved a bright student, the authors contend. Classifying 831 galaxies, the computer deviated from a panel of six expert observers only 9 percent of the time. That's not so bad, considering that panel members themselves agreed unanimously on only 8 of the 831 galaxies.

"Our results indicate that the [neural network] can replicate an expert's classification of the [galaxies] as well as the colleagues or students of the expert," the scientists conclude.

Early warning for oil spills

One of the biggest problems in managing oil spills arises from late detection. By the time someone sees a slick, the leak may already have caused substantial damage.

To combat this problem, chemist Chris W. Brown of the University of Rhode Island in Kingston and his colleagues have developed a sensor for early, remote monitoring of oil leaks. The sensor uses a small fiber-optic tip made of silver halides, a light source, and a spectrum-measuring device.

After a leak, oil touches the sensor's fiber surface and triggers a response. A monitoring system then alerts someone to the spill, while a computer generates a "fingerprint," or chemical profile, of the leak. The computer then compares the leak profile to a library of fingerprints from known oil samples.

Engineers could place the sensor in remote spots in power plants, oil refineries, rivers, and underwater aquifers.

Animating chemistry

Using the three-dimensional nature of molecules and the visual power of computers, some chemists are animating their field. Literally.

Led by Nathan S. Lewis of the California Institute of Technology, these scientists are designing broadcast-quality animation to exhibit chemistry's physical concepts. Lewis wants students to learn chemistry "with vigor, instead of just obtaining numerical answers on topics they don't fully understand."

Using topflight animation technology, the chemists, with help from some undergraduates, will produce videotapes 8 to 10 minutes long demonstrating various aspects of physical chemistry. Called the Chemistry Animation Project, it also enjoys guidance from film industry animators and graphic designers.

The scientists aim to distribute the animations to students internationally via videos, laser disks, and computer files.