

Coming Attractions

Taken from: Hubble 2006 Science Year in Review

The full contents of this book include more Hubble science articles, an overview of the telescope, and more. The complete volume and its component sections are available for download online at:

www.hubblesite.org/hubble_discoveries/science_year_in_review





A composite image of a galaxy, likely the Milky Way, shown in a curved, edge-on perspective. The galaxy's structure is visible, including the central bulge and the spiral arms. The image is overlaid with a dark grid pattern. The text "Coming Attractions" is written in a white, outlined font across the center of the image. A smaller, solid white version of the text "Coming Attractions" is positioned below the main title.

Coming Attractions

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Planets and Disks Around Nearby Stars

Since 1995, more than 200 planets have been discovered orbiting around nearby stars. The field has grown from a few intrepid astronomers looking for the minute changes in the velocity of stars due to the perturbations of orbiting planets, to hundreds of astronomers finding planets using radically different techniques. Kailash Sahu's article earlier in this volume describes how *Hubble* has been used to detect planets when they pass in front of the stars about which they are orbiting. If the star is bright enough, this transit technique can be used to constrain the size of the planet and probe its atmosphere. *Hubble* has successfully done this for a planet orbiting around the star HD 209458, and over the coming year will be carrying out similar types of observations on several recently discovered transiting planets. Particularly interesting is an upcoming attempt to detect clouds and water using infrared observations.

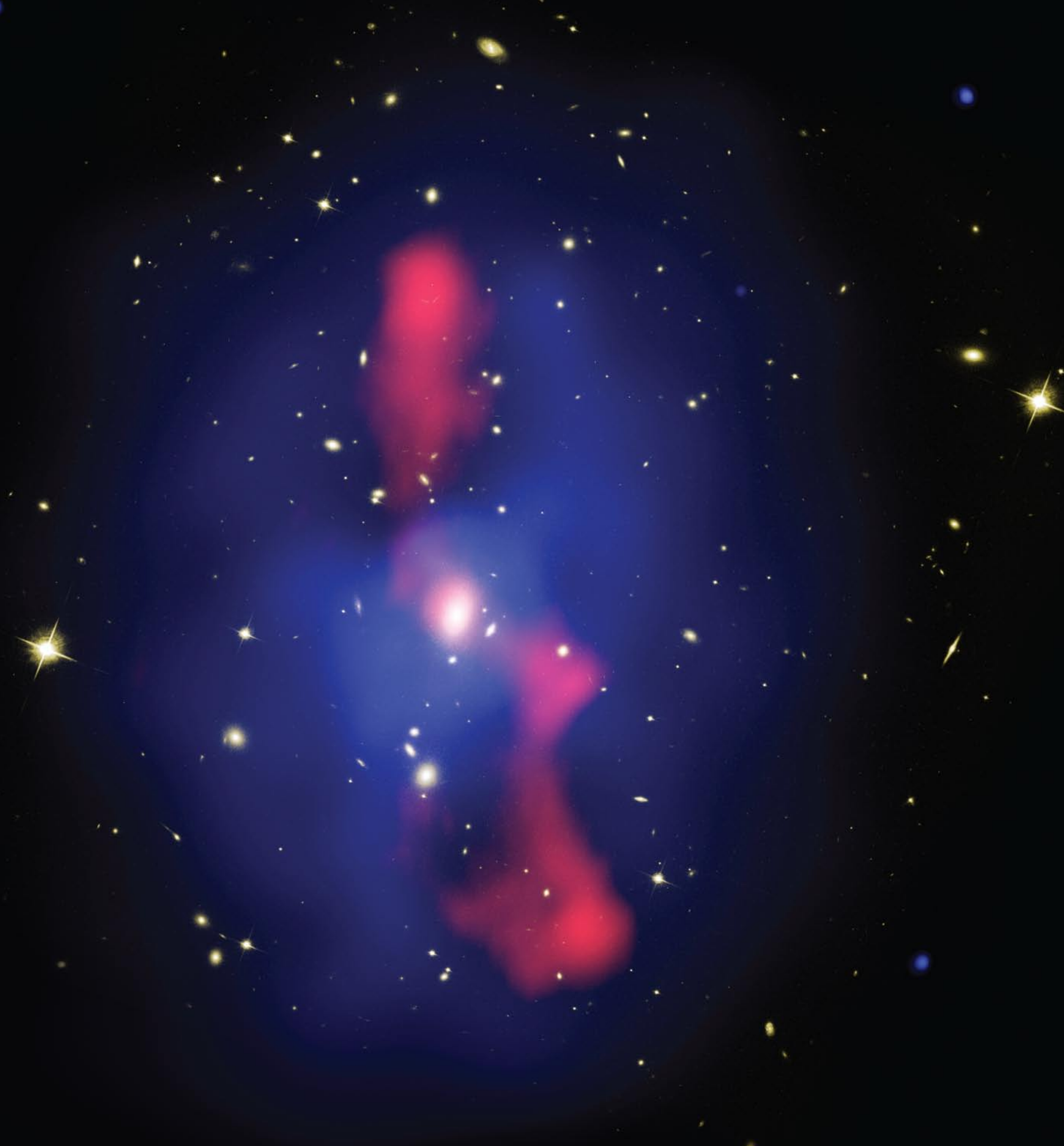
Another technique for finding or confirming the existence of planets is to search for tiny changes in the positions of stars in response to the orbiting planets. To date, this "reflex motion" has been detected in just a few planetary systems. Ongoing observations with *Hubble's* Fine Guidance Sensors are aimed at detecting this motion in another half-dozen planetary systems. By combining the *Hubble* positional data with the velocity data from ground-based telescopes, astronomers expect to make much more accurate estimates of the mass of the orbiting planets, and perhaps find additional planets in those planetary systems.

A related burgeoning field is the study of dust disks around nearby stars. Such disks now appear to be common around young stars, and are likely the ancestors of planetary systems. More and more disks are being discovered, especially because of observations by the *Spitzer* infrared observatory, which can detect their infrared thermal signature. Observations by *Hubble* over next few years will help to reveal the detailed structure of such disks, characterizing how their appearance changes around stars of differing ages, and perhaps revealing how they are sculpted by the gravitational influence of unseen planets.



Page 134–135: One of the universe's most stately and photogenic galaxies is the Sombrero galaxy, Messier 104 (M104). The galaxy's hallmark is a brilliant white, bulbous core encircled by the thick dust lanes which comprise its spiral structure.

Left: The parent star (highlighted with arrow) of the transiting planet mentioned in the opening paragraph on this page is called HD 209458. It lies 150 light-years from Earth, and can be found with binoculars in the constellation of Pegasus.



Nearby Clusters of Galaxies

Galaxies are not uniformly distributed in space. Instead, they tend to be found in groups and clusters, drawn together by their mutual gravitational attraction. Interestingly, the properties of galaxies appear to be strongly dependent on their environment. Galaxies in dense clusters tend to have older stars and are nearly devoid of the gas necessary to fuel star formation. Even today, galaxies that are surrounded by fewer neighbors tend to have more gas and are generally forming new stars. The physical mechanisms driving these differences are only partially understood. *Hubble* can help uncover the answers in a variety of ways. For example, the high resolution afforded by *Hubble* observations allows astronomers to find thousands of individual star clusters within the galaxies, and differentiate them from foreground stars in our own galaxy. The colors of these star clusters provide information on their ages and chemical abundances. By comparing the color distribution in different galaxies, astronomers hope to piece together a better history of star formation in the galaxies that inhabit nearby groups.

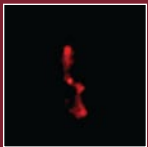
Hubble observations also provide detailed information on the central regions of galaxies, where stars often orbit under the influence of a supermassive black hole. By studying large collections of galaxies, astronomers hope to better understand the connection between the black holes and the surrounding stellar populations. Beyond the central regions, detailed measurements of galaxy shapes and color variations can help to provide information on how the galaxies have merged and interacted over time. *Hubble* observations will also likely reveal hitherto unknown dwarf galaxies, and help to constrain how galaxy properties vary as a function of mass. Scientific papers from the *Hubble* survey of the Virgo Cluster of galaxies are now appearing in the literature, and more are expected from the major surveys of the nearby Fornax and Coma clusters that are underway.



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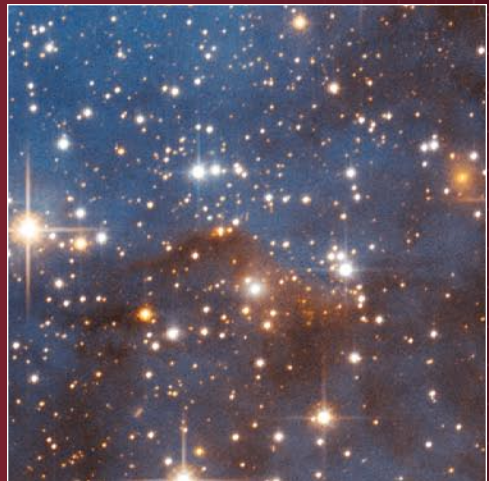


This is a new composite image of galaxy cluster MS0735.6+7421, located about 2.6 billion light-years away in the constellation Camelopardalis. The three views of the region were taken with NASA's *Chandra X-ray Observatory* (top image on left), *Hubble* (second one down) and the National Radio Astronomy Observatory Very Large Array (third one down).

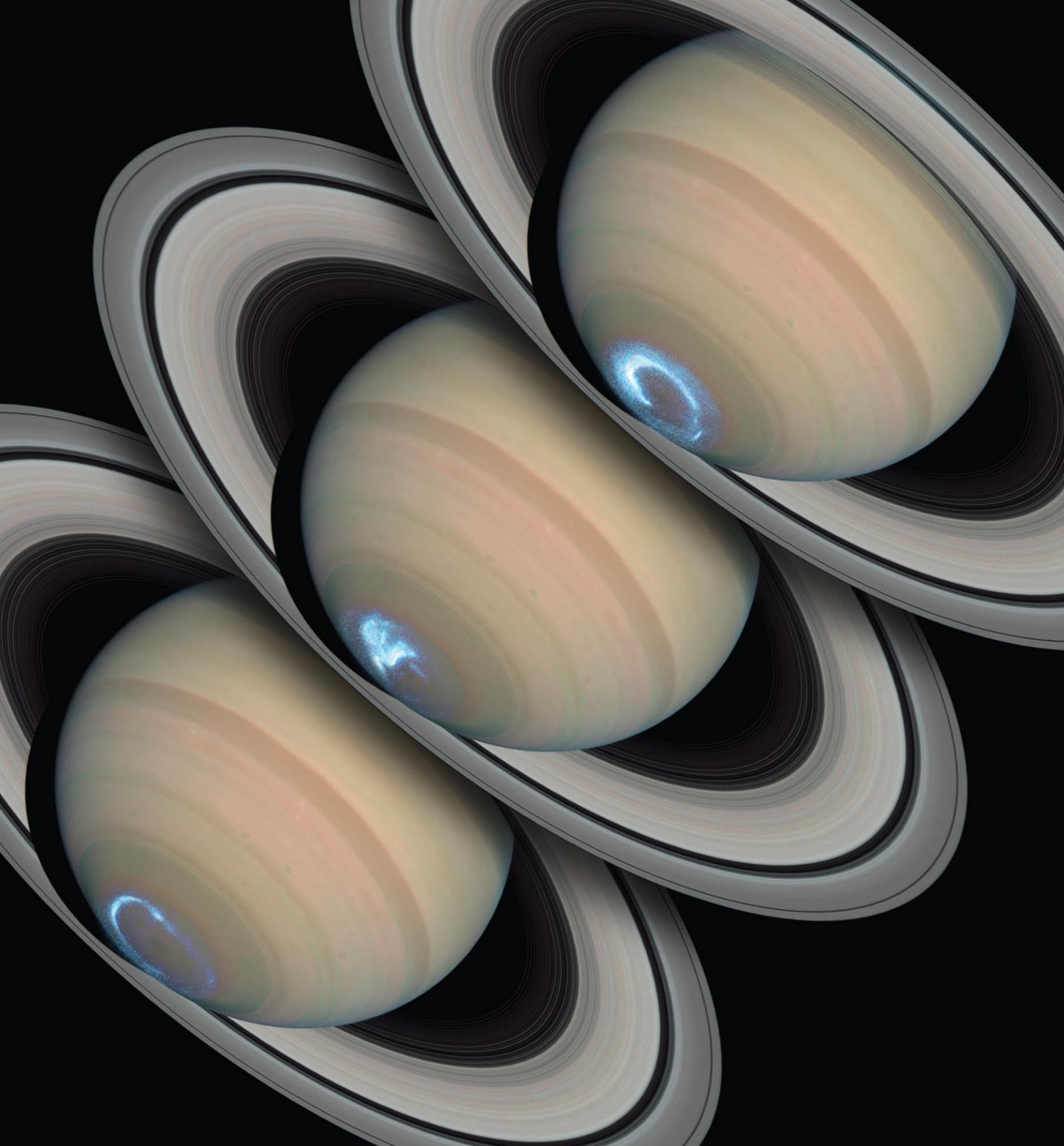


Stellar Populations in Nearby Galaxies

For galaxies closer to the Milky Way than those in the nearest clusters, *Hubble* observations can reveal individual stars. While the inner regions of most nearby galaxies are too crowded for a careful census, *Hubble* measurements of the positions, colors, and brightness of stars in the outskirts of galaxies provides a valuable probe of the “fossil record” of galaxy formation. Astronomers assemble the measurements of collections of stars into diagrams of color versus brightness, which can be compared to theoretical models to deduce the distribution of ages and chemical compositions of the stellar population. Over the past several years, observations have revealed that the outskirts of galaxies contain not only ancient stars left over from the initial phases of galaxy formation, but also stars more recently acquired from the destruction of dwarf galaxies by the tidal forces experienced when their orbits take them close to much larger galaxies. *Hubble* observations will help determine when, and how often, such encounters occurred.



Swirls of gas and dust reside in this ethereal-looking region of star formation imaged by *Hubble*. This majestic view of LH 95, located in the Large Magellanic Cloud, reveals a region where low-mass, infant stars and their much more massive stellar neighbors reside. The image was taken in March 2006 with *Hubble's* Advanced Camera for Surveys.



Jupiter and Saturn in the Heliophysical Year



Jupiter's Northern Aurora



Jupiter's Southern Aurora

One of the most beautiful phenomena in the night sky is the aurora borealis, or northern lights. These spectacular light shows occur when charged particles in the solar wind collide with atoms in Earth's upper atmosphere. The aurora is shaped by Earth's magnetic field, which can cause the auroral glow to take the form of curtains, arcs, rings, or rays.

Like Earth, Jupiter and Saturn both have aurorae. An extensive *Hubble* observing campaign in 2007 is targeted at determining the physical relationship of the various auroral processes at Jupiter and Saturn with conditions in the solar wind at each planet.

The year 2007 has been designated the International Heliophysical Year, and represents a unique period of especially concentrated measurements of space physics phenomena throughout the Solar System. The *Hubble* observations will be done in concert with measurements of the plasma density of the solar wind from the *New Horizons* spacecraft, now on its way to Pluto, and from the *Cassini* spacecraft, now in orbit around Saturn. The observations will allow astronomers to correlate the auroral behavior with the geometry of the local magnetic field and properties of the solar wind. For Jupiter, the observations will allow detailed study of the auroral "footprint" left by a river of electric current (of about 1 million amperes) that flows between the planet and its volcanic moon Io.



The dancing auroras on Saturn do not behave as scientists previously predicted. New research by a team of astronomers has overturned theories about how Saturn's magnetic field acts and how the planet's auroras are generated. The phenomenon is fundamentally different from that observed on Earth or Jupiter.