'Shepherd' satellite for Neptune's ring-arcs

The narrow, diffuse rings encircling Neptune display several singular features. In particular, the outermost ring contains a cluster of bright arcs, strung out like elongated beads along a dusty thread. Since their discovery in 1984, these ring-arcs, which correspond to concentrations of rocks and particles, have challenged the ingenuity of theorists who seek to explain why such features form and appear stable.

An analysis of data gathered by the Voyager spacecraft when it passed by Neptune in 1989 now suggests that a single satellite circling Neptune may supply the pattern of gravitational forces necessary to keep orbiting material confined to arcs. In the Aug. 30 SCIENCE, planetary scientist Carolyn C. Porco of the University of Arizona in Tucson proposes that the small satellite Galatea, which circles Neptune just 1,000 kilometers inside the arc-containing ring, has the right characteristics to act as a "shepherd," keeping trapped material from spreading out along the ring.

Neptune's ring-arcs lie about 60,000 kilometers away from the planet's center and cover about 10 percent of the ring's circumference. Individual arcs have a width of roughly 15 kilometers.

Porco's analysis of the Voyager data has yielded a number of clues crucial to solving the ring-arc mystery. She discovered that ring-arcs wiggle, periodically undergoing a distortion that shifts their radial positions by as much as 30 kilometers. This gravitational disturbance travels through the arcs at the right speed to be associated with Galatea, she says. Other observational evidence points to a second important influence, also associated with Galatea, that prevents the particles from spreading out along the ring. Together, the two perturbations keep the particles confined to certain ring positions, Porco suggests.

The shepherding influences of a single satellite provide "the most plausible explanation for the confinement of Neptune's ring arcs," she says. "But it may not be the whole story."

One difficulty is that individual arc particles would have to travel in orbits that cross each other to account for the width and radius of the arcs. "That's the weakness in this picture," says Peter Goldreich of the California Institute of Technology in Pasadena. "There would be frequent collisions, and that would tend to destroy the arcs." Before Voyager's arrival at Neptune and the discovery of Galatea, Goldreich and his collaborators had raised the possibility that a single satellite might be responsible for the ring-arcs.

The origin of the ring-arcs poses another puzzle. Porco's model indicates which ring sites could serve as particle traps, but it doesn't specify which ones are actually filled. "The observation that Neptune's arcs are so few in number and clustered so closely . . . suggests that they may well have had their origin in the collisional disruption of a small moon," she says.

Her data analysis has also turned up additional arcs. "To the eye, it looks like there are three main arcs, but there are really five," Porco says. "And I wouldn't be surprised if there are more."

The Voyager data may yet contain other important clues concerning the origin and stability of Neptune's ring-arcs. "We're not finished," Porco says. "There's still much more work to be done." — *I. Peterson*

JPL

Voyager photograph shows three bright arcs along Neptune's outermost ring.

Brain feature linked to sexual orientation

A comparison of 41 autopsied brains has revealed a distinct difference between homosexual and heterosexual men in the brain region that controls sexual behavior. The finding supports a theory that biological factors underlie sexual orientation, although it remains unclear whether the anatomical variation represents a cause or result of homosexuality, says neurobiologist Simon LeVay, who describes the study in the Aug. 30 SCIENCE.

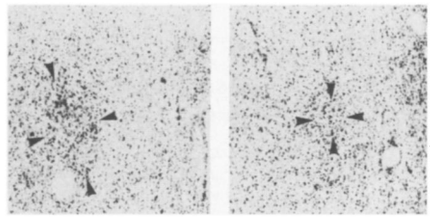
LeVay, of the Salk Institute for Biological Studies in San Diego, found that a particular cluster of cells in the forefront of the hypothalamus was, on average, less than half as large in the brains of homosexual men as in their heterosexual counterparts. Although scientists have yet to identify the precise function of the clump, called the interstitial nuclei of the anterior hypothalamus 3 (INAH 3), the hypothalamus is known as the seat of the emotions and sexual drives.

LeVay obtained brain tissue from autopsies performed at seven hospitals in New York and California. His study included 19 homosexual men, 16 men presumed heterosexual, and six women presumed heterosexual. All of the homosexual men died of AIDS, as did six of the heterosexual men and one of the heterosexual women.

As a group, the heterosexual men had larger INAH 3 regions than either the homosexual men or the heterosexual women, LeVay reports. The size difference remained statistically significant whether or not the subjects died of AIDS, ruling out the possibility that it resulted from the disease, he says.

"This proves that you can study sexual orientation at the biological level," LeVay asserts. "There are differences in the brains of adult gay and straight men." However, he warns, "my data don't say how that difference arose."

Previous investigations have turned up other contrasts. In 1984, scientists at the State University of New York at Stony Brook confirmed a German study showing that male homosexuals differ from heterosexual males or females in their response to injections of the sex hormone estrogen (SN: 9/29/84, p.198). And last year, researchers at the Netherlands Institute for Brain Research reported that homosexual men had a larger suprachiasmatic nucleus than heterosexual men. The suprachiasmatic nucleus — which plays a role in day-night rhythms — also resides in the hypothalamus but has no known part in sexual behavior.



LeVay/SCIENCE

Arrows outline hypothalamic cell clumps in the brains of heterosexual (left) and homosexual (right) men.

Psychologist Sandra F. Witelson at McMaster University in Hamilton, Ontario, reported last year that lesbians show a higher incidence of left-handedness than the general population. Witelson, who studies handedness as a measure of brain organization (SN: 8/17/85, p.102), told SCIENCE NEWS she has now found a similar incidence in homosexual men.

Together, the studies conducted to date "really show that there's something different in the [brain] anatomies of homosexuals and heterosexuals," she says.

Witelson and LeVay speculate that atypical levels of sex hormones may shape the brains of homosexuals in the womb or during childhood. This explanation does not rule out environmental influences, Witelson notes. "A certain brain structure could be a predisposition to homosexual behavior that requires a certain environment to be expressed," she says. — *C. Ezzell*