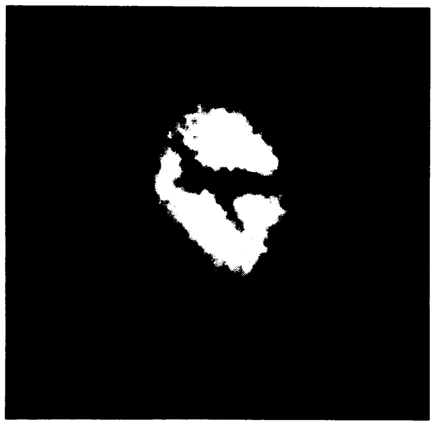
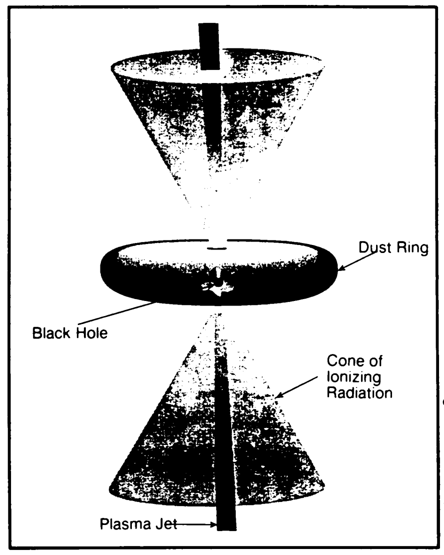
Hubble image (near right) shows dark X against the nucleus of the galaxy M51. The X may mark a black hole with as much mass as a million suns. The wider arm of the X may represent a dust ring seen edge-on. Drawing (far right) depicts dusty, light-obscuring ring that may hide a black hole at M51's center. Recent evidence suggests that the dusty ring determines the direction in which jets of hot gas are ejected from the vicinity of the black hole. The ring may also confine radiation – emitted by infalling matter – in oppositely directed cones that ionize gas caught in their beams.





Images: Ford et al./NASA

merely wanted to follow up on ground-based radio and optical observations of M51, a flat, spiral galaxy seen nearly face-on from Earth. Those studies had provided tantalizing evidence that M51 has an active nucleus: Its core contains hot, ionized gas moving at speeds of up to 2 million miles per hour, as well as material packed into two gas-inflated bubbles.

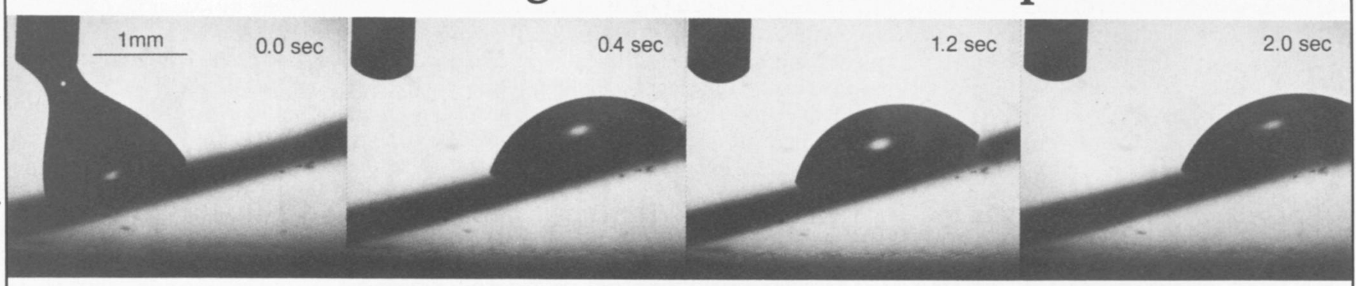
Two newly released Hubble images provide the sharpest views yet of M51's core. One shows a pair of cone-shaped searchlights streaming out from the center in opposite directions, each leaving a glowing trail of ionized gas. The other image, taken at a different wavelength, shows the dark X, with the fatter arm bisecting the apex of the twin searchlights.

Ford and his co-workers propose that this arm represents an edge-on view of the doughnut that researchers have long sought – a rotating ring of cold gas and dust that somehow got tipped out of the plane of the flattened galaxy. The doughnut may obscure the "central engine" – the presumed black hole at the core of M51 – as well as infalling material from an inner disk of hot gas needed to feed the black hole. The researchers speculate that the doughnut, about 100 light-years in diameter, also directs the ionizing radiation emitted by the infalling matter. Light passing through the hole would emerge as twin cones, similar to the image Hubble obtained.

Since a rotating doughnut has a characteristic light spectrum, researchers intend to test these ideas by analyzing emissions near the fat arm of the X. This week, astronomers will analyze spectra taken with a telescope in Hawaii. Later this year, Ford's team plans to use Hubble's faint-object spectrograph for a similar study.

The thinner arm of the X remains a puzzle. It could represent a second doughnut seen edge-on or gas and dust interacting with the galaxy's energetic core, says Ford. In either case, it indicates that astronomers still don't fully understand what drives the fireworks at the center of M51. *– R. Cowen*

Chemical tug can make water flow uphill



Chaudhury & Whitesides/SCIENCE

No photographic illusion, this water droplet really is charging uphill. Under the right conditions, water defies gravity and slips up a slope (left to right), even when the surface tilts 15° upward, says Manoj K. Chaudhury, a physicist at Dow Corning Corp. in Midland, Mich. He and Harvard University chemist George M. Whitesides worked this trick by exposing a silicon wafer to a plume of a silicon-carbon chlorine compound called decyltrichlorosilane.

The vapor plume makes the wafer surface hydrophobic, or water repelling. The scientists distribute the vapor so that more reacts with the lower end of the wafer and less at the top. Because water tends to move toward the least hydrophobic surfaces, it will slide upward, Chaudhury explains. By varying the wafer's time of exposure to the vapor, the scientists control the degree of difference between water-repelling properties of the top and bottom edges of the wafer.

The researchers treated a 4-centimeter-long wafer, put a 1-microliter drop on it and photographed the drop's movements over a 5-millimeter-long section. The gradient in the wafer's hydrophobic properties causes a gradient in the surface tension experienced by the droplet, says Chaudhury. The front edge of the drop feels a more attractive force than the back edge, so the drop oozes upward at rates of 1 to 2 millimeters per second. On flat surfaces, larger drops move faster than smaller ones, but tinier ones move more readily on slopes, the scientists report in the June 12 SCIENCE.

In the past, other researchers created temperature gradients to push a drop uphill, "but nobody has shown this using a chemical gradient like we did," Chaudhury says.

French theorists predicted several years ago that scientists could use hydrophobic forces to move water. But to get the chemical gradient to work, Chaudhury and Whitesides discovered they needed to make the surface very smooth and free of defects. "Once you know how to do it, it's simple," says Chaudhury. They have made other liquids slide uphill as well, including thick ones.

Though done to satisfy the scientists' curiosity, this experiment could lead to a better understanding of fluid dynamics of individual drops, especially the physics involved at the junction of air, liquid and solid boundaries, Chaudhury says. It will also aid in the study of the interaction of thermal and chemical forces on drop movements, he adds.