of all positives and negatives, should always remain zero. And so it does in these quark-jet cases, but in such a way that one jet appears to have a bias for positive charge, the other a bias for negative charge.

To get the neutral balance nevertheless this means in effect that the left-hand jet knows what the right-hand jet is doing. For that to be so, the bias must go back to their origins, to the quarks. One of them must be biased to one kind of charge, the other to the other kind, and together they must balance out. So the evidence seems to be showing that quarks have electric charge. □

Grime fighting with superoxide

Those stubborn halogenated hydrocarbon industrial wastes. Try dumping them, and they persist in the environment; try incinerating them, and acid pollutants are exhausted. Looks like this is a job for "superoxide" — a form of the oxygen molecule that has one extra electron.

Superoxide, under specific conditions, has the power to detoxify certain halogenated hydrocarbons — the derivatives of hydrogen-carbon parent molecules that contain a halogen (chlorine, bromine or iodine, for example). This special ability of the negatively charged form of oxygen is reported by Donald T. Sawyer of the University of California at Riverside and Julian Roberts of the University of Redlands in California in the Feb. 11 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

While studying the electrochemical properties of oxygen dissolved in special inactive solvents, Sawyer and Roberts observed that in the presence of an electrical current and in the absence of water, superoxide breaks the diehard carbon-chlorine bonds responsible for the persistence of substances such as the chemical waste chloroform ($CHCl_3$) and the pesticide DDT. In a dozen or so nearly spontaneous steps, superoxide replaces the tenacious carbon-chlorine bonds with carbon-oxygen bonds, converting the halogenated hydrocarbons into substances that have the component baking soda made famous — carbonate (CO_3^{-2}).

Currently, the cheapest alternative to dumping halogenated hydrocarbons is incinerating them. Sawyer says that even though the superoxide method uses electricity, it eventually could be cost-competitive with incineration. "The rationalization here is that the electrochemical process may be expensive, but it also is highly specific and will get rid of only the carbon-chlorine bonds," he explains. "It won't do chemistry on the other constituents in the mess." Incineration, on the other hand, burns up everything from the hazardous chemicals to those that could be recycled fuel sources. □

Shuttle test


Wide World

At 8:45 a.m. EST on Friday, Feb. 20, an elaborate, two-day countdown climaxed with the spectacular 20-second firing of the U.S. space shuttle's three powerful main engines. It was the first time they had been fired while mounted to the shuttle vehicle, and the last before they are ignited for a longer burn (together with a pair of "strap-on" auxiliary rockets) to carry the craft on its maiden flight to orbit. The test was deemed a success, and NASA officials continued to speak of an early-April launching, despite some thermal material that still needs rebonding to the shuttle's external fuel tank, and a strike begun by several hundred launch-pad workers only 15 minutes after the engine-firing was completed.

Mapping two-faced Dione

Janus, a literally two-faced Roman deity, was the name proposed for a small satellite of Saturn first detected (though its orbit was incorrectly calculated) in 1966. Another Saturnian satellite, however, known as Dione — whose name no one is about to change — would certainly seem to be a fit candidate for the title in view of the Voyager 1 spacecraft's recent photos, which show it to be a strikingly two-faced moon.

Dione's trailing hemisphere — the one that faces behind in its orbital motion — reveals long, bright, "wispy" features seemingly painted on the dark, cratered terrain, while the leading side merely shows the familiar, dark-colored craters and some intervening plains. Now the photos have been transformed into a map (see pages 138 and 139) that clearly portrays the Dionean dichotomy. Drawn by airbrush at the U.S. Geological Survey's Branch of Astrogeologic Studies in Flagstaff, Ariz., the map was deliberately made with resolution only as sharp as the photos can confirm. Proposed names for surface features are now being evaluated by a committee of the International Astronomical Union. Some additional coverage will be provided by Voyager 2, which will fly past Saturn in August.

The wisps, suggests Laurence Soderblom of the USGS, may be water that froze onto the surface after "outgassing" through cracks in the crust. The cracks might have been due to the expansion of Dione's water-rich interior as it froze, or perhaps even to tectonic activity. The satellite's density of 1.45 grams per cubic centimeter might be just enough to allow for some radionuclides as the source of the necessary heat for tectonics, Soderblom very tentatively points out, and indeed, similar wisps may exist on portions of Rhea (see map, SN: 2/14/81, p. 108), slightly less dense at 1.35 g/cc. Either hypothesis, he says, suggests that wisps might once have covered the whole of Dione, later to be preferentially obliterated from the leading hemisphere by the impacts of solar-system debris. A few large craters also show on the wispy side, and Soderblom poses a scenario in which Dione's initial formation was followed by an episode of widespread cratering (from the general meteorite bombardment believed to have taken place throughout much of the solar system), after which came the fracturing and resultant "wisping" and finally the scouring of the leading hemisphere.

A different possibility, suggested by Eugene Shoemaker of the USGS, is that the cracks might be fractures caused by a single big impact. Many of the wisps do seem to radiate from a single general region, and near its center is a dark, ring-like shape which, if it is indeed a crater, is one of Dione's largest, more than 200 kilometers across. Such a localized origin for the cracks might also explain the lack of wisps on the opposite side.

One of Dione's oddest features, in a sense, is not part of Dione at all, but the fact that it shares its orbit with another moon, discovered about a year ago and unofficially dubbed Dione B. Far smaller than Dione itself (perhaps 50 to 100 km across, versus 1,120), "B" circles Saturn ahead of Dione's position, sometimes behind and sometimes ahead of one of the so-called Lagrange libration points at which it is held in a gravitational balance by Dione and Saturn. The idealized point (L_4) is 60° ahead of Dione, but a satellite would tend to oscillate around that point for a variety of reasons such as less-than-idealized geometry in the original gravitational interactions that placed the two moons in the same orbit. This week, Harold Reitsema of the University of Arizona reported that Dione B's angular separation from its big companion varies between 46.9° and 76.4°, taking about 787 days to complete one cycle. (At least one other pair of co-orbital Saturnian moons, yet unnamed, is also known to exist, much closer to the planet — the larger of which, ironically, is the object that was originally proposed for the name Janus. And U.S. Naval Observatory researchers are now analyzing the possibility that Tethys may be sharing its orbit with not one but two librating companions.) □