Lawrence Berkeley Laboratory and the Stanford Linear Accelerator Center, working with the SPEAR storage ring at SLAC, found the same particle in collisions of electrons and positrons and named it psi. Since then, a series of half a dozen or more related particles have been discovered or claimed in various laboratories.

On all of this, theorists have had a field day. Becker says more than 2,000 theoretical papers have been published in the past year, in attempts to explain the J-psi phenomena. Each new experimental finding causes theorists to adjust their hypotheses and provokes a new spate of publication. So feverish is the activity, says Becker, that "excited physicists from all over the world often call the MIT control room at Brookhaven at 2 or 3 o'clock in the morning to ask Professor Ting or me for our latest results, instantly modifying their theories accordingly." But amidst major and minor differences of opinion and ad hoc modifications as experiments continue, the overwhelming majority of the theorists opt for some form of the charm hypothesis.

To this Becker responds that the recent MIT experiments show that "the current theoretical attempts to explain the J particle probably need major modifications." In fact, from the actual experimental results only a few conclusions about the J-psi's can be drawn, according to Ting and Becker.

The discovery of a series of particles representing excited states of the basic J-psi indicate that it is a bound system of a particle and antiparticle. (Whether the constituents are a charmed quark and an anticharmed antiquark, as most theorists seem to have concluded, experiment doesn't say.) The pattern of observed excited states is similar to that for positronium, a bound system consisting of an electron and a positron. Also the J-psi is definitely a hadron, one of the large group of particles that responds to the strong interaction, the force that holds atomic nuclei together. "Unfortunately, this is all that can today be concluded from the experiments," Ting says.

And now, the MIT-Brookhaven experiment, which has produced more than 50 million pieces of data and for which Becker claims a sensitivity at least a thousand times that of any other in the United States or Europe, yields "no trace of any indication of charmed particles." In fact it gives evidence against charm.

If the charm hypothesis is true, then when charmed particles are produced in proton-proton collisions, the ultimate decay products should include about equal numbers of electron-kaon pairs and electron-pion pairs. In fact, the number of electron-kaon pairs was less than one percent of the electron-pion pairs.

So the MIT group concludes that the J-psi's are still very much an enigma, unexplained misfits in the world of subatomic particles. □

Purple salt-lover captures the sun

'Purple protein' high resolution map.

Halobacteria are salt-loving cells that inhabit stagnant puddles and salt flats at the edge of tropical seas. They prefer the surrounding environment pickled—or nearly so—with salt concentrations approaching the saturation point. They turn water orange and red herrings red and turn sunlight into chemical energy on their "purple membranes." These bacteria are, all in all, very strange organisms.

The National Aeronautics and Space Administration is intensely interested in strange organisms. For years, NASA has funded research on life under extreme conditions. And now, with Viking speeding toward Mars, interest in unique life systems has doubled. *Halobacterium halobium's* "purple membrane" turns out to be the only living unit other than chlorophyll-containing systems that is capable of changing sunlight into chemical energy (photosynthesis). The bacterium, therefore, fits both NASA interests—it lives under extreme conditions and has a unique life system—and has been the target of NASA-funded research. Six biologists held a press conference Tuesday at the University of California at San Francisco to discuss recent advances in *H. halobium* research and the significance of this strange cell to scientists in medicine and agriculture.

Walther Stoeckenius, a cell biologist at UCSF, first discovered the purple membrane about five years ago. The bacterium generates patches of the purple membrane just under its cell wall when oxygen or nutrients grow scarce in the surrounding salt water. The proteins in the special membrane then receive photons of light and turn them into chemical energy that the cell can use to power its life functions until oxygen and nutrients build up again. The protein is called bacteriorhodopsin and is similar to the retinal pigment, rhodopsin, in human eyes. Stoeckenius and co-workers have "mapped" the structure of this protein at high resolution, and it is, at present, the only membrane protein so characterized.

Rhodopsin in the eye, he explains, functions as a photoreceptor and signal transducer, which translates light energy into nerve impulses, and uses stored chemical energy in the process. Bacteriorhodopsin, on the other hand, receives light, and during a series of proton (H+) exchanges, stores energy in the form of ATP to power the cell. The system is less efficient than chlorophyll-based photosynthesis, but it is simpler and may help researchers understand energy exchanges in other organisms. And the similarity between bacteriorhodopsin and rhodopsin has been a windfall for eye physiologists.

Other news conference participants were Richard J. Havel, Richard Lozier and Roberto Bogomolni of UCSF, and Harold P. Klein and Janos Lanyi of NASA Ames Research Center. They and others, studying the unique photosynthesis of *H. halobium*, hope that it will lead them to a more refined understanding of photosynthesis in plants and light reception in the eye, as well as preparing NASA for any strange new life mechanisms Viking may find on Mars. □

CEQ: Water, air show improvement

Air quality in the United States has generally improved and the worst sources of water pollution are being effectively controlled, according to the sixth annual report to the President by the Council on Environmental Quality. Conditions for wildlife, however, are deteriorating in many areas, and a new appreciation of the dangers of environmental carcinogens is emerging.

In the five years since passage of the Clean Air Act Amendments, atmospheric concentrations of particulate matter have declined an average of 14 percent, and average sulfur dioxide concentrations have declined 25 percent, CEQ reports. Many urban areas are also showing improvement in ambient levels of carbon monoxide and photochemical oxidants (smog).

Water quality, measured by 87 monitoring stations, generally showed improvement, with no stations reporting "severe" conditions in 1974. By that year, 92 percent of all stations registered "good or fair" conditions (violation frequencies of less than 40 percent). However, eutrophication of lakes in the eastern states continues to increase, ocean dumping increased 20 percent in 1974 alone, and the statutory deadline for installing secondary sewage treatment will apparently not be met by most cities.

Recycling of solid wastes received a "major setback," the report concludes, and the "recycling boom of the early 1970s appeared to be over," as many volunteer recycling centers went out of business. Prospects for the long run remain promising, however, as the costs of new materials continue to rise.

Wildlife continues to bear the brunt of human expansion. Commercial ocean fishing continues to seriously reduce numbers of the most plentiful fish off U.S. coasts—populations of some stocks are only about half those of the early 1960s. On shore, approximately one out of every 10 animal and plant species native to the United States may now be endangered or threatened.

One of the most disturbing discoveries of recent research is that 60 to 90 percent of all cancer is related to environmental factors and that 15 to 40 years may pass between exposure and tumor development. The majority of known carcinogens are encountered in the workplace, but the sheer volume of new chemicals (some two million compounds are now known) has impeded full understanding of their possible hazards.

What does it all cost? Estimates by CEQ show that each American will spend (indirectly) some $98 in 1976 for environmental improvement and that costs will rise to 2.5 percent of gross family income by 1983. More jobs have been created than lost in the effort. □

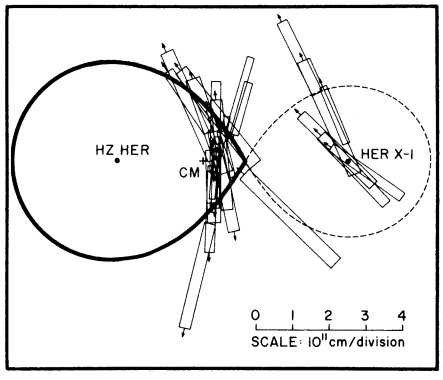
Her X-1: A middleweight neutron star

Several of the newly discovered pulsating X-ray sources or X-ray pulsars are members of binary star systems. This fortunate fact gives a hope of determining the mass of the body emitting the X-rays by studying the interactions of the two members of the binary. Determining the masses is important in deciding just what the X-ray sources are, because theory assigns different mass ranges to the possible candidates: white dwarfs, neutron stars or black holes.

Using the classical physics techniques by which astronomers have weighed stars for centuries, a group at the Massachusetts Institute of Technology determined a mass for the X-ray source Vela X-1 to an accuracy of about 30 percent (SN: 9/20/75, p. 182). Now two astronomers from the Lawrence Berkeley Laboratory, John Middleditch and Jerry Nelson, have determined the mass of Hercules X-1. The latest in sensitive optoelectronic observing equipment enabled them to make the determination, which they call "the first precise measurement of the mass of a pulsar, or neutron star." An accuracy figure of 10 percent is quoted.

Hercules X-1, as Middleditch and Nelson describe it, is a binary system consisting of an aged blue star and a dark companion that revolve around each other every 1.7 days. The gravitational interaction between the two bodies has distorted the outer atmosphere of the blue star into a teardrop shape with its pointed end toward the dark companion. Through the point of the teardrop, gas streams from the blue star onto the surface of the dark companion. This activity generates heat (to a temperature of more than 100 million degrees) that causes the surface of the dark companion to emit X-rays with an energy 10,000 times the energy of the sun's emissions.

The dark companion is a rotating body with a strong magnetic field. The magnetic field makes the X-ray emission directional like a lighthouse beam, and the rotation carries it around with a frequency of one



Univ. of Calif., Berkeley

Teardrop shape of HZ Herculis outlined by light flashes generated as X-ray pulses from Hercules X-1 strike its surface.

circuit every 1.24 seconds. During part of the sweep, the X-ray beam strikes the atmosphere of the blue star. The X-rays cause the matter they strike there to emit pulses of visible light.

What Middleditch and Nelson have succeeded in doing, believe it or not, is to detect these visible pulses as individual photons. To do so they used a sensitive photomultiplier tube mounted on the 61-centimeter telescope at the Lick Observatory on Mt. Hamilton near San Jose, Calif. The photon events were recorded on magnetic tape and analyzed for periodic patterns by a computer at LBL.

The results of that analysis allowed Middleditch and Nelson to determine the shape of the blue star's teardrop atmosphere, and that plus the duration of the eclipse as the dark companion passes behind the blue star (known in optical catalogs as HZ Herculis) permits calculation of the masses of the two stars. The dark companion's mass comes to 1.3 times the sun's mass, well in the range that theory predicts for neutron stars. Its diameter is about 20 kilometers.

Middleditch and Nelson hope to use the same method on other bodies, especially black holes, using the rapid light variations that should occur as gas from companion stars falls into them. □

Images of Venus by infrared

Astronomers have long studied Venus in the infrared in an effort to probe the secrets of its visually featureless atmosphere. The earliest attempts were simply full-disk measurements, basically nothing more than single, bulk temperature readings. In 1963, Bruce C. Murray, James A. Westphal and Robert L. Wildey made the first infrared "maps" of the planet, but the scan lines used to construct the maps were widely spaced, requiring the researchers to interpolate to produce their contour lines. The results thus were not true images.

Now David J. Diner, Westphal and F. Peter Schloerb of the California Institute of Technology have produced what they call the first true, high-resolution, infrared images of the Venusian atmosphere. As the 200-inch Hale telescope on Palomar Mountain scanned slowly across the planet's face in an east-west direction, the researchers used a moving secondary mirror to step quickly and automatically along measured, north-south intervals, producing a series of precise, vertical scan lines, each one arc-second wide and overlapping its predecessor by half its width.

Using a relatively large bandwidth of 8 to 14 microns, the Caltech team assumed the bright parts of the images represented a temperature of 230°K, based on the Mariner 10 spacecraft's non-imaging infrared detector. This, they report in ICARUS (27:191), implies that the features in the images are at about the 50-millibar pressure level in the atmosphere, which Diner says is about 80 kilometers above the Venusian surface.

The original, unenhanced version of the image shows what appears at a glance to be a bright spot at the south pole, bordered by a dark "collar." Actually, the scientists report, the south and north poles appear at about the same brightness; it is the dark collar, which also appears in the earlier "maps," that is the anomaly, making the south pole seem brighter.

With contrast enhanced by a computer, the image, in fact, confirms previous signs that the planet's polar limbs are darker than the equatorial limbs. The same technique also reveals a number of more subtle blotchy and band-like features, though they represent temperature differences of only 1° to 3°K. Even the difference between the planet's day and night sides (the dawn terminator is roughly along the inside edge of the bright spot at the left-hand edge of the enhanced image) is only about 2°K.

More important than the specific features in these first images, says Diner, is the potential of the precise, moving-mirror technique to show whether infrared features in the atmosphere correspond to ultraviolet ones, such as those photographed