SPACE SCIENCES

The flattened atmosphere of Mars

When the planet Mars briefly cut off the earth's view of the magnitude 3.2 star Epsilon Geminorum last spring, numerous astronomers throughout North America, the Caribbean area and Great Britain took note of the event. It is estimated that Mars occults such a bright star only about once in 500 years, says Gordon E. Taylor of the Royal Greenwich Observatory in England, which would mean that it last happened more than a century before Galileo made his contributions to the telescope. Predicted times and coordinates were thus sent out well before the occultation of April 8, 1976, enabling a large number of observers to study the Martian atmosphere by its effect on the star's light shining through it, just before the star disappeared behind the planetary disk.

One result made possible by the wide geographic distribution of the observers was an improved estimate of the oblateness or polar flattening of the Martian atmosphere. This is important not only as information about the planet, but also as light-scattering information necessary for accurate calibration of other earth-based observations of Mars. Sightings from Maryland, Georgia, Texas and an aircraft over the western North Atlantic enabled the occultation of the star to be studied along nearly 30° of the planet's edge, and along about 15° of the edge where it reappeared, thus providing a reasonable sample of the atmosphere's curvature.

The resulting conclusion, reports Taylor in the Nov. 11 NATURE, is that the oblateness of the atmosphere is about twice that of the surface of the planet. There was one slight difficulty: Mars as seen from the earth was not fully illuminated by the sun at the time. This means that the star disappeared behind a dark edge and reemerged from behind a bright one, so that diurnal variations could have affected the atmosphere's density at the time. A 1971 stellar occultation by Jupiter, however, showed no such effect, says Taylor. Although the solar influx per unit area is greater at Mars than at Jupiter, he concludes that the Martian atmospheric flattening, defined at the level where the star's light was reduced by 50 percent, is in the range of from 0.012 to 0.014.

Criteria selection for female astronauts

With the space agency planning to include women in the space shuttle's astronaut corps, physicians at the NASA Johnson Space Center in Houston are gathering baseline data on female physiological performance and tolerance limits as an aid to developing candidate selection criteria.

The test program in female physiological performance is being conducted on up to 150 volunteers, all of them employees at JSC. Cardiovascular responses are measured in two tests: on a tiltable, adjustable-speed treadmill and in a system called a lower-body negative-pressure device, which encloses the subject from the waist down while the air pressure in the device is reduced. This enables the physicians to measure cardiovascular changes due to reduced external pressure around the lower torso and legs. Electrocardiograms and vectorcardiograms will be taken during the tests, as will other noninvasive measurements that evaluate heart sounds and mechanical efficiency of the heart. Voluminous data exist on male responses to such tests, but female responses have heretofore been studied to a much lesser degree.

The call for shuttle astronaut candidates was issued in July, with emphasis on hopes for applicants of both sexes. As of Nov. 15, 440 completed applications had been received at JSC (out of 8,515 initial inquiries), of which 43 were from women. The deadline for applications is June 30, 1977, with selection of the 30 candidates to be completed by December 1977.

PHYSICAL SCIENCES

From our reporter at the annual meeting of the Plasma Physics Division of the American Physical Society in San Francisco

Solar flares and earthly plasmas

Solar flares may resemble twisted tubes of plasma, so-called stabilized pinches often seen in terrestrial laboratory experiments. This is a proposal presented by Stirling A. Colgate of the Los Alamos Scientific Laboratory that results from considerations of how typical theoretical models of solar flares do not fit observations of X-rays and solar cosmic rays that the flares are supposed to produce.

The X-rays seen have energies of 10 kilo-electron-volts or more requiring an energy between 10^{11} and 10^{12} times the observed energy of the flares if the X-rays are produced by heat as the usual theory supposes. Furthermore, the cosmic rays exhibit more helium 3 than helium 4, and deuterium is far less abundant than expected.

Both these difficulties can be removed if one assumes that a solar flare is a twisted flux tube of plasma arching up from the surface of the sun and back down to it in which the energy is mainly invested in a current of protons. An optimally directed flux of 10 mega-electron-volt protons could provide all these phenomena as they are observed. All of this, he says, is consistent with the observed facts of a flare of Aug. 21, 1972, that he quotes as a "canonical" example. The energy of this flare was 10^{32} ergs, its length 2 billion centimeters, the radius of its tube about 100 million centimeters, and it lasted 1,000 seconds. All these figures are consistent with the flares being a twisted plasma tube of the sort proposed, and the total energy of the flare corresponds to the self-energy of a tube of protons of such a size. The model, Colgate concludes, gets a large number of things correct about helium-rich flares.

Banana-shaped orbits of stars

The combination of the rotation of stars around the centers of galaxies and the existence of spiral arms in those galaxies can result in some rather strange and complicated stellar orbits that tend to resemble those of particles in some kinds of laboratory plasmas. The orbits can also be treated analytically in a way similar to plasma particles. This is brought out in a paper by three physicists from the Massachusetts Institute of Technology, Giuseppi Bertin, Bruno Coppi and A. Taroni.

Modern theory regards the spiral arms of galaxies as a pattern of standing density waves. The combination of the rotations of stars and the rotations of the spiral arm patterns and the exchange of angular momentum between stars that rotate with less and more than the speed of the spiral provide three kinds of orbits: circulating, trapped and alternating.

The trapped orbits come about because the combination of the different overall rotations of the galaxy sets up libration points where stars can become trapped. The trapped orbits tend to be banana-shaped paths around these libration points. The banana-shaped orbits are similar to orbits of the same shape sometimes followed by charged particles in certain plasmas.

It turns out that the resonance between the general rotation of the galaxy and that of the spiral arm pattern is broad enough so that the bananas, if they start with relatively small amplitudes about the libration points, can gradually increase in length until the stars become detrapped and enter circulating orbits that carry them all around the galaxy. Then perhaps, after a few rotations, they may come near enough to a libration point to get trapped into a banana again. So all in all, the rotational motion of stars around a spiral galaxy is not a simple circular drift, but possible combinations of circulating drift, trapped banana-orbits and an alternation between the two.