physical sciences

New national voltage standard

There has been a trend in recent years to base measurement standards, where possible, on physical constants or processes that are easily and exactly reproducible. On July 1 the legal volt joined the trend, according to an announcement by the National Bureau of Standards.

From now on the definition of the standard volt will be based on the alternating-current Josephson effect. Two pieces of superconducting metal separated by a thin slice of insulating material form a Josephson junction. If a voltage is applied to the junction, electron pairs will tunnel back and forth through the insulator. The alternating current thus formed will have a frequency that is equal to the voltage times twice the quotient of the charge on the electron divided by Planck's constant [$V(2e/h)$]. Since the electron charge and Planck's constant are fundamental constants, the standard volt can thus be determined by tuning a Josephson junction to the proper frequency.

Waves of superfluid vortex rings

Electrically charged particles moving through superfluid helium with the proper amount of velocity can cause the formation of vortex rings. The charged particles will become attached to the rings they create.

In a stream of charged vortex rings the individuals interact with each other by both electrical and hydrodynamic forces. In the June 26 PHYSICAL REVIEW LETTERS Akira Hasegawa and C. M. Varma of Bell Telephone Laboratories present a theory to show that the electrical forces make such streams capable of collective vibrations or waves. For frequencies below a certain critical value, the waves will be unstable, and their amplitudes will grow exponentially. At higher frequencies they will be stable.

In the same issue of PHYSICAL REVIEW LETTERS George Gamota of Bell Labs reports that he has been able to observe the growing waves and that they conform to the theory as presented. At frequencies much higher than the critical value a direct comparison between theory and experiment is not possible until a certain equation has been solved.

Blackbody radiation from a bumpy universe

The microwave background radiation that appears to pervade the universe is generally taken to be blackbody radiation left over from the early moments of the big bang. The smoothness (isotropy) of the radiation appears to indicate that it comes from a time when the universe was homogeneous and smooth. Indeed this is just the picture given in the traditional big-bang theory, which sees the universe in its early moments as being made up of smooth homogeneous radiation.

The universe today, as witnessed by the existence of galaxies and clusters of galaxies, is slightly clumpy. Cosmologists worry about how it could get that way (SN: 2/26/72, p. 140). M. J. Rees of Cambridge University (now visiting the Harvard College Observatory) wants to turn the argument around. He says the great mystery is how the universe acquired its present large-scale smoothness, not the small-scale inhomogeneities. In the June 19 PHYSICAL REVIEW LETTERS he points out that there is no *firm* evidence that the universe was ever smoother than it is now.

Assuming that the early universe possessed the maximum inhomogeneity compatible with the present amount of smoothness, he goes on to show how the blackbody radiation could be generated by dissipation of energy possessed by the clumps. Numerically the temperature of Rees' proposed blackbody comes to 3 degrees K., equal to the measured value.

Nonthermal radiation of quasars

Quasars and galactic nuclei produce a significant amount of light that does not come from heat. There are two possible mechanisms for this: direct production of optical photons by synchrotron radiation or Compton scattering of radio photons from the source. In the latter, the radio photons collide with electrons and are shifted to optical frequencies.

Detection of circular polarization in the light could resolve the difference. Synchrotron radiation is produced by electrons moving in orbit in a magnetic field. If the light were directly produced by the synchrotron process, circular polarization of 0.1 percent would require a magnetic field of about 200 gauss. This is a highly unrealistic field for astronomical objects of this kind.

But that amount of circular polarization is actually found in the radio waves from some of these objects. Thus if so much polarization exists in the visible light, it would argue that the visible light was originally radio photons and got shifted by Compton scattering.

So far the search has yielded null results. In the June 15 ASTROPHYSICAL JOURNAL LETTERS J. D. Landstreet of the University of Western Ontario and J. R. P. Angel of Columbia University report no positive result in a look at six quasars and the nuclei of three Seyfert galaxies.

The nature of Iapetus

The Saturnian satellite Iapetus appears two magnitudes fainter when farthest east of Saturn than it does at farthest west. A number of explanations have been forthcoming: that there is a sharp difference in reflecting power between two sides of the satellite; that a thin surface of ice or snow has been differently eroded by meteorites on the two sides; that the satellite is highly elongated and rotates with two-thirds of its orbital period.

The latest contribution, polarization measurements by Ben Zellner of the University of Arizona, reported in the June 1 ASTROPHYSICAL JOURNAL LETTERS, gives support to the idea that two hemispheres of a spherical satellite have sharply different reflecting power.

An optically variable galaxy in Hercules

A 17th-magnitude object in the constellation Hercules, V395 Her, appears to be extragalactic rather than a star, Howard E. Bond of Louisiana State University writes in the June 15 ASTROPHYSICAL JOURNAL LETTERS. If that is so, it makes V395 Her a member of a very small group: objects known to be optically variable that turn out to be extragalactic. The others are the Seyfert galaxy BW Tauri, and the peculiar objects, BL Lacertae and AP Librae. Unlike the other three, V395 Her is not a known radio source.