# physical sciences

## Shortening the second

On Jan. 1, 1972, the standard second by which official clocks keep time will be shortened. This will be effected by substituting atomic-clock standards for the astronomical ones now in use.

In the past the world kept time by noting the recurrences of astronomical phenomena, particularly the rotation and revolution of the earth. Astronomers came to define a standard second as a certain fraction of the tropical year, the time between successive appearances of the sun at the vernal equinox. The problem is that each year's second is not the same as another year's because the rate of the earth's motion varies. Over the long term it is slowing down.

Oscillations within atoms are more constant, and standard clocks based on them are now practical. The constant second that will be used is based on a fraction of the tropical year 1900. Since the astronomical second is longer now than in 1900 and is getting longer all the time, the atomic standard clocks will have to add about one additional or "leap" second a year to stay in synchronization with astronomical phenomena. (This is similar to adding a day in leap year.) If the second were not added, at the end of about 37,000 years, the atomic clock would be a day out of phase with the calendar.

## New stellarator results

A stellarator is one sort of device with which physicists are experimenting in attempts to achieve controlled thermonuclear fusion. Stellarators are in many respects similar to the tokamaks that have lately become popular in the United States and in the Soviet Union. Both are toroidal chambers in which magnetic fields attempt to confine plasmas of ions and electrons. The major difference is that in a stellarator the field is generated by coils exterior to the plasma; in a tokamak, by a current inside the plasma.

Evidence is growing that stellarator and tokamak plasmas behave similarly. One piece of such evidence is reported in the Sept. 20 JETP LETTERS by A. G. Dikii and 11 others of the Physico-Technical Institute of the Ukrainian Academy of Sciences. In the stellarator Uragan they found that a plasma with a high electron temperature loses energy to the surroundings even while the particles remain relatively confined. That is, the confinement time for particles is 5 to 10 times that for energy. Similar phenomena have been noted in tokamaks (SN: 6/26/71, p. 434).

## A very high-energy cosmic ray

In spite of advances in the technology of accelerators, cosmic rays remain the source of the most energetic particles physicists can measure. The upper limit on cosmic-ray energies is now increased to 10 times what it was before according to a report in the Dec. 6 PHYSICAL REVIEW LETTERS by K. Suga, H. Sakuyama, S. Kawaguchi and T. Hara of the University of Tokyo.

Their observations recorded showers of particles produced when cosmic-ray particles strike nuclei of gas atoms in the atmosphere. They found one shower that had to come from a primary particle with an energy of $4 \times 10^{21}$ electron-volts. The radio source 3C 409 and the pulsar AP2015+28 are possible sources of that primary, say the Japanese researchers.

## The split $A_2$: Chapter N

For several years now particle physicists have been engaged in an argument over whether the $A_2$ meson is one particle or two (SN: 5/8/71, p. 315). The source of the dispute is an apparent dip in the peak of the mass spectrum for the $A_2$. Normally the mass spectrum of a particle—in which thousands or hundreds of recorded individual particles are plotted on a graph of number versus mass—will be a narrow bell-shaped curve. The $A_2$ spectrum sometimes appears with a dip in the top that makes some people suspect there are really two overlapping curves. This could mean there are two particles.

But explaining the dip on that basis leads to theoretical difficulties. Two optical analogies, based on the fact that particles are also waves, are now put forward to explain how an unsplit $A_2$ could have such a dip. In the Sept. 1 PHYSICAL REVIEW D (just issued) D. C. Peaslee of the Australian National University in Canberra draws an analogy to optical selfabsorption. Light emitted in a thick sample of gas—on the sun, for instance—may be partially reabsorbed on its way out. Likewise, Peaslee suggests that some $A_2$'s produced when pi mesons are struck against protons may be reabsorbed before they get out of the proton. The other suggestion, by A. B. Kaidalov in the Sept. 20 JETP LETTERS, is that the dip may be caused by destructive interference between the matter waves of the $A_2$ and those of the background particles in the interaction. This would be analogous to the destructive interference between light waves out of phase with each other.

## Magnetic fields in peculiar objects

Circular polarization in the light from astronomical bodies can be evidence of magnetic fields in them. N. S. Nikulin, V. M. Kuvshinov and A. B. Severny of the Crimean Astrophysical Observatory report in the Dec. 1 ASTROPHYSICAL JOURNAL LETTERS observations that lead them to suspect circular polarization of more than one percent in the Seyfert galaxies NGC 4151 and NGC 1068 and the quasar 3C 273. In the X-ray source Sco X-1 they find a rapidly varying circular polarization. They suggest that two dense magnetic stars rotating rapidly and orbiting rapidly around each other could cause such rapid variation.

In Cygnus X-1, a possible source of X-rays, similar variation was found.

## Temperature of Mars

In reviewing radio observations of Mars, astronomers have noticed a discrepancy in the measurements of the temperature of whatever on Mars is emitting 8.57-millimeter waves. Observations before 1969 gave 210 to 235 degrees K. A more recent measurement gave 176 $\pm$ 5 degrees. In the Dec. 1 ASTROPHYSICAL JOURNAL LETTERS P. M. Kalaghan and L. E. Telford of the Air Force Cambridge Research Laboratories report that observations taken during the recent close approach of Mars gave 175 $\pm$ 15 degrees.

Temperatures measured at various wavelengths are used to make models of the thermal and electrical characteristics of the Martian surface (SN: 6/19/71, p. 424). Solving this discrepancy helps to decide among possible models.