are using a still different approach. Haught says that one cannot get a net fusion yield with an inertially confined plasma unless one puts in at least 10^7 joules; so he is concentrating his efforts on confinement of laser plasma by a magnetic-containment field, which he says will avoid injection difficulties associated with other magnetic-confinement experiments. Haught hopes to produce within a magnetic-containment field about 10^{15} ions/cm^3 at several keV by laser irradiation of a small solid particle. He would then use the resulting plasma as a target for a neutral injection beam, which could then serve to further heat and sustain the plasma. —GBL

Ultracold Neutrons May Refine Electric-Dipole-Moment Value

A group from the Joint Institute for Nuclear Research at Dubna, F. L. Shapiro, V. I. Lushchikov, Yu. N. Pokotilovskii and A. V. Strelkov, has trapped very low energy (10^{-7}eV) neutrons that could be used for sensitive electric-dipole-moment experiments.[1] Because these ultracold neutrons have low velocities, they are present for a relatively long time in an experiment chamber and are thus more susceptible to effects than are faster particles.

Nonzero nucleon or electron electric-dipole moments would be a violation of time-reversal invariance; so experimenters have been looking for them since CP violations were first found (PHYSICS TODAY, March 1968, page 71). One could also look at the interaction between ultracold neutrons and an electric field to see whether the neutron has a net charge.

Very slow neutrons (velocity up to 10 meters/sec) are expected to experience total internal reflection within a vacuum vessel at any incident angle;[2] one should then be able to accumulate and store them. In the Dubna experiments a 6-kW (average power) reactor was pulsed every five seconds. The group set a bent, polished copper vacuum tube (9.4 cm × 10.5 meters) between the reactor and an experiment hall and put a detector outside the direct beam path but within the tube.

Counting began one second after the pulse; the ultracold-neutron counting rate was 0.01 pulses/sec. Comparison of this value with the counting rate when the tube was filled with helium to 1-torr pressure showed neutron diffusion time to be about 200 sec.

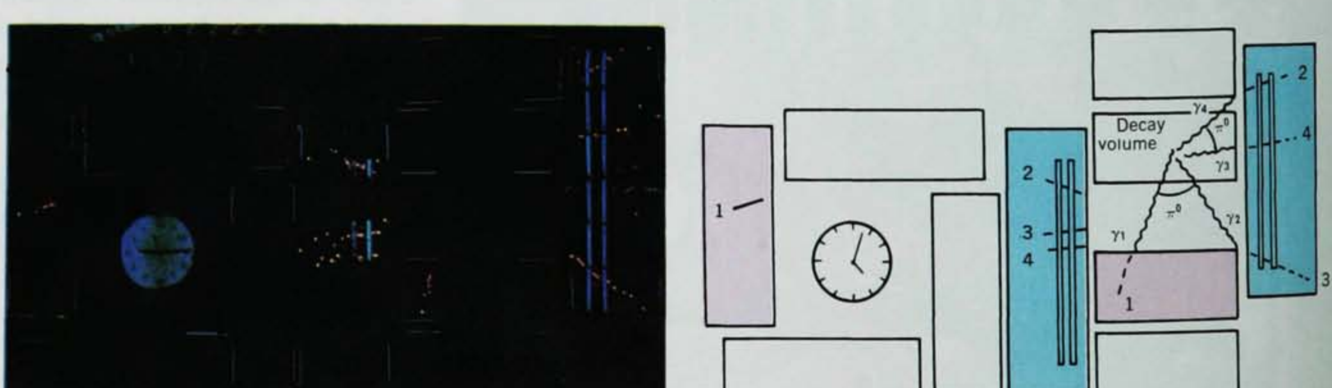
Shapiro and his coworkers are still busy characterizing the neutrons (density, type of reflection undergone) and have not yet planned the specific experiments that would use them as a tool. Work was transferred to the Kurchatov Institute in Moscow because the Dubna reactor has been shut down.

Steyerl from the Munich Technische Hochschule research reactor has also detected these slow neutrons but has not reported containment.

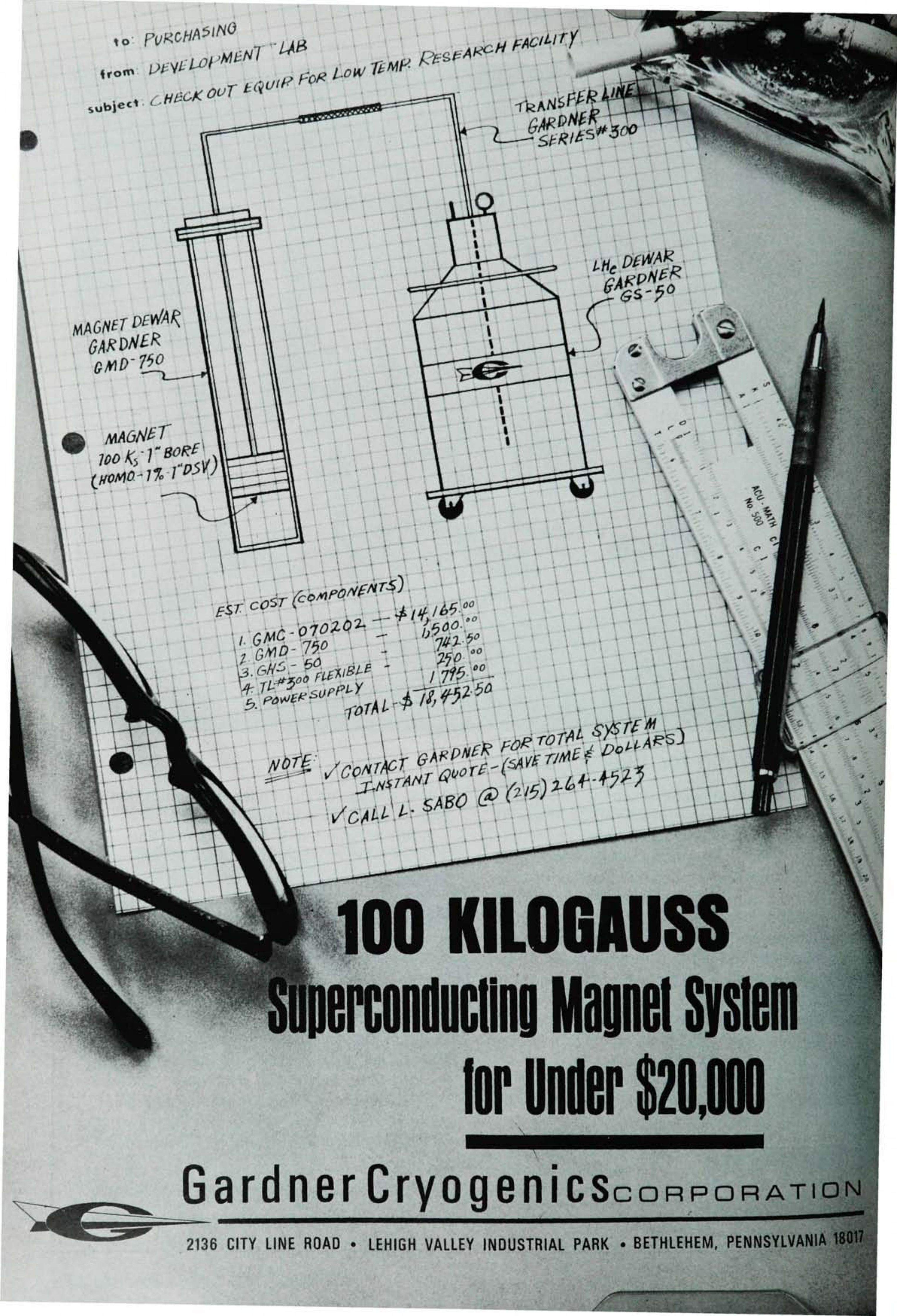
Neutron moment. Studies with the ultracold neutrons could give dipole-moment values more precise than present values by a factor of 100, according to Clifford Shull of MIT. He and Robert Nathans[3] placed an experimental upper limit of 6×10^{-22} e cm on the neutron electric dipole moment. Recently Philip D. Miller, Norman F. Ramsey, James K. Baird, and William B. Dress[4] have refined this upper limit to 5×10^{-23} e cm. They used 115 meter/sec neutrons.

To improve their electric-dipole measurement Miller's group at Oak Ridge is building an arrangement similar to the Russian apparatus. Theirs will be a copper "bucket"–a tube 38 cm by 15 cm, which will have an entrance for the cold-neutron beams and an exit to detectors. Both ends will have gates that can be closed. The neutron containment time is to be determined by shutting the tube entrance and then measuring counting rate versus time.

Miller expects to get neutrons as slow as 6 meters/sec, about the same as the Dubna neutron velocity. If results are good enough, the bucket will be made part of a very narrow-band magnetic-resonance spectrometer to



CP-VIOLATING DECAY OF LONG-LIVED K MESON. A Berkeley–University of Hawaii collaboration recently measured the rate of the CP-nonconserving decay $K_2^0 \rightarrow 2\pi^0$ relative to that of $K_2^0 \rightarrow 3\pi^0$ (*Phys. Rev. Lett.* 22, 1210, 1969). In the decay, which was photographed with the aid of 46 mirrors, a K_2^0 crossed the decay volume and decayed into two neutral pions. One π^0 decayed into γ_1 and γ_2; the other π^0 decayed into γ_3 and γ_4. Each gamma ray then entered a spark chamber and produced a cascade shower. The cascade from γ_1 is visible in the two views of one spark chamber (which are colored alike) taken 90 deg apart; similarly the cascades from γ_2, γ_3 and γ_4 are visible in the two 90-deg views of a second spark chamber (also colored alike). The Berkeley-Hawaii experiment is one of several attempts to measure the decay rate.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further improve precision of the data.

Experimenters at MIT plan to use a cold moderator that is now being installed at the MIT reactor to increase cold-neutron intensity; both the MIT and Oak Ridge groups expect to be doing experiments within a year.

Proton moment. To search for a proton electric dipole moment, P. G. H. Sandars, S. J. Wright and G. E. Harrison at Clarendon Laboratory, Oxford, have done high-precision molecular-beam-resonance experiments with thallium fluoride.[5] They interpret their null result as placing an upper limit of $(7 \pm 9) \times 10^{-21}$ e cm on the proton moment. —MSR

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Transition-Radiation Detector Shows Promise for High Energy

The transition-radiation detector being tested at Brookhaven National Laboratory appears to be a promising technique for identifying superhigh-energy particles. When a particle crosses the boundary between two media it emits electromagnetic radiation—"transition radiation." Such radiation needs a boundary, unlike bremsstrahlung, Cerenkov radiation or ordinary fluorescence.

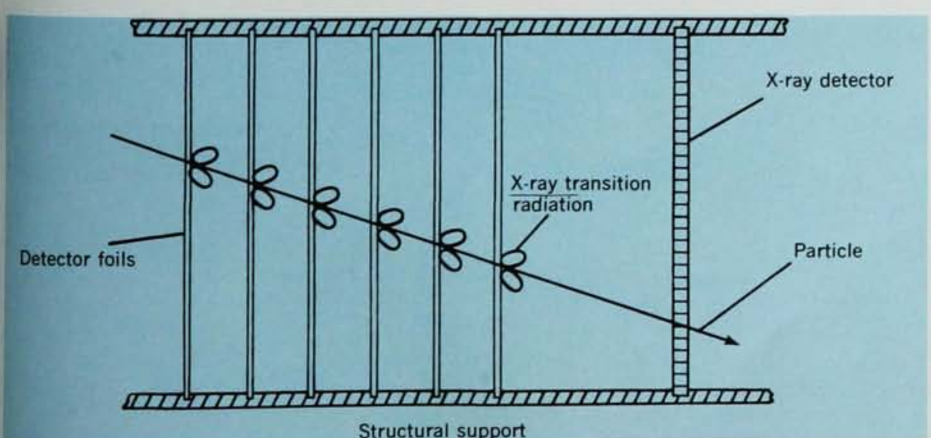
Theory had predicted that in the optical region the intensity of the radiation varies as log γ, where $\gamma = (1 - \beta^2)^{1/2}$, $\beta = v/c$ and v is particle velocity. Experiments by Luke Yuan and his collaborators over the last two years confirmed the logarithmic dependence.

A much more useful feature of the transition radiation, however, is that, in the x-ray region, theory predicted that intensity is linearly proportional to γ, or even better. Now Yuan, Ching Lin Wang and Sepp Prunster have made preliminary measurements (*Phys. Rev. Lett.* **123**, 496, 1969) in the x-ray region, in which the radiation is emitted by individual 2-GeV positrons at the Cambridge Electron Accelerator. The transition radiator is a stack of 231 thin aluminum foils, 25 microns thick and spaced 0.3 mm apart.

Positrons pass through a beam-defining scintillation-counter telescope, then through the transition radiator. A bending magnet then deflects the positrons into a scintillation counter. The x-ray transition radiation is measured by a lithium-drifted germanium detector. The Brookhaven experimenters estimate that 12 x-ray photons were produced by each positron. They now plan to try verifying the dependence of intensity.

Yuan points out that although detection of relativistic particles is comparatively easy, identification and selection of specific particles is a lot more difficult. Detection is done well by cloud and bubble chambers, solid-state and scintillation detectors, Cerenkov counters and photographic emulsions; all these respond to β. Yuan points out that because γ is much more sensitive to the mass of a high-energy particle than β, the transition-radiation detector offers a unique method of mass identification of monoenergetic particles in the superhigh-energy region.

Yuan, Anthony Favale and John Dooher (both of Grumman Aircraft) have proposed orbiting a high-energy physics experiment that puts the transition-radiation detector in tandem with the total-absorption nuclear-cascade (TANC) detector of Robert Hofstadter and collaborators (PHYSICS TODAY, May, page 58). The TANC would measure particle energy, and the transition-radiation detector could measure γ; so one could obtain particle rest mass. The transition-radiation detector could be calibrated with the 20-GeV electrons at SLAC, which have the same γ as 36 000-GeV protons.



TRANSITION-RADIATION DETECTOR. When particle crosses boundary between two media it emits x-ray transition radiation, whose intensity is expected to vary as log γ. Brookhaven detector has 231 thin aluminum foils.

International Space Project Will Study Solar Processes

NASA and its West German counterpart will coöperate in Project Helios, a space mission to study solar processes. According to an agreement signed in June, NASA will launch two German-built spacecraft on Atlas-Centaur rockets. The launchings, planned for 1974–75, will be approximately a year apart and will carry the space probes three tenths of the distance from the earth to the sun, further than any other flight now scheduled.

Ten experiments are planned in this exploration of the interplanetary medium, including studies of the solar wind and of electron plasma oscillations. Seven of the experiments are being planned by German scientists and the remainder by NASA in coöperation with American, Australian and Italian experimenters.

Another joint venture of the two countries will be an aeronomy satellite.

IN BRIEF

A 25-ton piece of CER-VIT (PHYSICS TODAY, February 1968, page 55) nonexpanding glass was poured in June. Ten minutes were required to pour the glass, which will form the mirror of the 158-inch (400-cm) telescope at the new Cerro Tololo Inter-American Observatory in Chile (PHYSICS TODAY, December 1967, page 59). □