is negligible. "The influence of matter starts at a later stage when the universe expands a little. At the later stage the influence of matter becomes stronger and stronger, and we come from this isotropic origin to the present, isotropic state. What about the future? The Einstein equations are nonlinear. Our result shows a singular behavior is possible, but a nonsingular solution is also possible."

Misner told us that because the mathematics is completely symmetric between the beginning and the end, once the universe changes from its present expansion, a singularity will occur in the future. However, the transition from expansion to contraction is not a clear prediction of the theory; it only occurs in closed models.

Landau Institute. Despite the fascinations of cosmology, Khalatnikov has also been interested and active in quantum field theory, and most of all, solid state. For twenty years he collaborated with Landau, until the automobile accident in 1962 that ended Landau's professional career. They both worked in the Institute for Physical Problems, headed by Peter Kapitsa. "Kapitsa discovered superfluidity and Landau explained it," Khalatnikov said. From the beginning Khalatnikov specialized in superfluidity: he wrote a book in the Frontiers in Physics series, "Introduction to the Theory of Superfluidity" (Benjamin, New York).

When it became clear that Landau would not recover, a group of his collaborators at Kapitsa's institute decided to found a new institute, and after his death it was named in his honor. The founders were: Khalatnikov, Alexei Abrikosov, who specializes in solid state and high-energy physics, Igor Dzheleshinski, well known in theory of magnetism and problems in statistical physics, and Lev Gor'kov, one of the leading physicists in superconductivity.

"Then some people from different places joined our group: Mark Az'bel is well known in theory of metals and wave propagation in metals. Anatoly Larkin is a universal man, working most recently with Lev Aslamazov (a young man from our institute) on the influence of fluctuations on the resistivity of superconductors near the transition point (paraconductivity).

"Emmanuel Rachba is an expert in theory of excitons, semiconductors and ionic crystals. Gerasim Eliashberg is a very talented man, who works in nonstationary properties of superconductors, collaborating with Gor'kov. Valery Pokrovskii (who came to us from Novosibirsk) works in high-energy physics and superconductivity; his most famous work was with Alexander Patashinskii—some of the first work on theory of phase transitions was done by them."

Dzheleshinski's work on high-tempearture superconductors has been significant, Khalatnikov noted. William Little had suggested one could make organic-type superconductors with high transition temperature, using a one-dimensional polymer. Then Pierre Hohenberg, basing his work on that of Nikolai Bogoliubov, showed that one cannot achieve superconductivity in one or two dimensions. But Dzheleshinski showed one can have some systems close to one dimensional (in which the interaction is much stronger in one direction than in the others) that could be superconducting at high temperature.

The institute has about 11 or 12 men with doctor's degrees (roughly equivalent in prestige to being a fellow of the American Physical Society); it has around 20 "candidates" (roughly the same as our PhD), about 15 graduate students and some undergraduates. The institute has the right to give scientific degrees and diplomas. Its location, Chernegelovga (it means a small black hat) is a new scientific center, which contains a few different institutes—physics, solid state, chemistry. —GBL

References

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SIN to Begin Accelerating Before the End of 1973

SIN (Schweizerisches Institut für Nuclearforschung, or the Swiss Institute for Nuclear Research) has begun to prepare the site for its meson factory at Villigen near Zurich. The design of this machine was recently discussed by Jean-Pierre Blaser. A variable-energy cyclotron will accelerate pro-

tons to 70 MeV and a second cyclotron will complete acceleration to 500 MeV with an expected current of 100 microamperes. The facility can be used for experiments with the low-energy beams of the injector cyclotron or for intermediate-energy physics with both accelerator stages.

Because both stages are isochronous (sector-focusing) cyclotrons they yield a continuous beam with 100% macroscopic duty cycle. The main cyclotron has eight C-shaped spiral sector magnets with the field varying from 14 kG to 20 kG between the injection radius of 2.1 meters and the extraction radius of 4.5 m. In four of the gaps between magnets, rf cavities give a total energy gain of 2 MeV per orbit, ensuring a radial separation of 8 mm per orbit and hence high extraction efficiency.

The Swiss accelerator is only one of several meson factories nearing completion (PHYSICS TODAY, December 1966, page 27). At Los Alamos the Meson Physics Facility, with an expected beam of 800 MeV and 1 milliampere, may be in operation by 1972 (PHYSICS TODAY, May 1969, page 65). With the previously unavailable high intensities of pion and muon beams provided by these new machines, one can study problems ranging all the way from nuclear physics to radiation biology. —BGL

Phase Matching Achieved in Circularly Polarized Waves

C. Kumar N. Patel and Nguyen Van Tran report that they have obtained phase matching between circularly polarized waves in nonlinear interactions (Appl. Phys. Lett. **15**, 189, 1969). Phase-matched interactions in linearly polarized waves have made use of the birefringence in crystals. However, this technique cannot be extended to circular polarizations because the rotary dispersion in crystals exceeds the rotary birefringence. Patel and Van Tran applied a magnetic field to an electron plasma in a semiconductor to increase circular birefringence. The field was aligned along the common directions of propagation of two circularly polarized input waves and the output wave generated by phase-matched difference frequency mixing. The magnetic field allows tunability of phase matching for different input frequencies. □