

international cooperation is obviously working at Serpukhov, no American physicists have managed to get their equipment through the door yet. Discussions have been going on from time to time over the past few years, and at least three informal proposals have been made by groups headed by S. J. Lindenbaum of Brookhaven, Jay Orear of Cornell and Luke C. L. Yuan of Brookhaven.

The day before our visit, US Atomic Energy Commissioner Gerald Tape and Igor Morokhov, first deputy chairman of the Soviet State Committee for the Utilization of Atomic Energy, had signed a memorandum of agreement for the exchange of scientists at various laboratories of their respective organizations. Serpukhov is one of the laboratories.

The following day Tape and Anatoly Alexeivich Logunov, director of the Serpukhov institute, discussed the possibility of American physicists doing experiments at Serpukhov.

Since Soviet progress in computers is not as great as that in the US, one lively prospect is the Lindenbaum proposal. He would like to bring an array of scintillation-counter hodoscopes, electronics and a part of the Brookhaven on-line data facility, complete with a PDP-6 computer, to Serpukhov. The apparatus has already been successfully used to measure pion-proton and proton-proton scattering at small angles for incident momenta from 8 to 26 GeV/c (PHYSICS TODAY, May 1967, page 63). At Serpukhov one could easily extend these measurements beyond 60 GeV/c.

One not-so-obvious problem raised by international cooperation is, what do you do with all the foreign newcomers? When 100 French scientists and technicians arrive next year to operate Mirabelle, the laboratory town of Protvino will have to provide housing for 400 additional people.

Protvino and the High-Energy Physics Institute are actually 20 km away from Serpukhov, which is about 100 km south of Moscow. The 2500 scientists and technicians of the institute live in Protvino. Support workers and families also live there; population is about 20 000.

**Competition.** Despite their obvious desire for international cooperation, the Serpukhov physicists we met seemed to feel the same sort of competition with American high-energy physicists that is so apparent between

Russian and American space scientists.

At lunch we chatted with Serpukhov physicists including Logunov, Ado, Alexei Naumov, deputy director, and Yuri Prokoshkin, chief of the experimental department. One American suggested a joint effort to build a 1000-GeV accelerator. A Russian rejoined, "We are grateful to you for building the 30-GeV Brookhaven machine because that meant that we could build our 70-GeV machine. And we are grateful that you are building the 200-GeV machine at Weston because that means that we can build a 1000-GeV machine here—by ourselves. Of course that's my personal point of view." — GBL

### **Stanford Group Builds Visible CW Parametric Oscillator**

A continuously operating visible optical parametric oscillator was recently reported by Bob Byer, Kenneth Oshman, Jim Young and Stephen Harris of Stanford (*Appl. Phys. Letters*, 1 August). The oscillator uses the cw output of an argon laser at 0.5145 micron as pump and lithium niobate as the nonlinear crystal. The signal wavelength is tunable from 0.6800 to 0.7050 micron with the idler in the corresponding range 2.11 to 1.90 microns in the infrared.

Besides operating in the visible region of the spectrum, Harris explained, his oscillator differs from the earlier cw oscillator of Richard Smith and his collaborators (PHYSICS TODAY, June 1968, page 60) in two respects. First, since the frequency spacing of the idler modes is equal to the frequency spacing of the modes of the pumping laser, the oscillator uses the total multimode pumping power of the driving laser. Although the pump modes may be randomly phased and erratic in amplitude, corresponding behavior of the idler modes compensates to allow continuous pumping of a single signal mode.

Second, since the Stanford oscillator operates relatively far from degeneracy and also uses a relatively long crystal (1.65 cm), the measured bandwidth of the parametric oscillator is about ten times less than that of previous oscillators. Total oscillation bandwidths of about three wave numbers are observed.

A maximum average output power of 1.5 mW is observed when the pumping power is 2.8 times the

threshold value. The output mirror of the oscillator has a transmission of 0.04%; it is expected that larger powers will be obtained with optimum output coupling. The parametric output consists of pulses that are typically 0.1–1.0 millisecon long. The oscillator wavelength may be continuously tuned by changing the temperature of the crystal, and the oscillator maintains nearly constant power output during the tuning process.

### **Fast Chemical Kinetics Studied with Laser Light**

Scattering of laser light off molecules in solution can yield previously unknown information on the kinetics of ionic chemical reactions. Yin Yeh and Norris Keeler (Lawrence Radiation Laboratory) have studied solutions of simple salts in chemical equilibrium. Ionic reactions occur spontaneously in such solutions, dissociation of molecules and association of ions causing continuous local variations from equilibrium; the relaxation time for return to equilibrium gives the rate of the ionic reaction. These reactions are too fast and involve too few molecules for standard chemical-kinetic methods to work.

Yeh and Keeler shone a 63.28-micron-wavelength helium-neon laser beam into salt solutions and looked for Doppler broadening of the scattered light; the degree of observed broadening was a measure of the reaction rate. So far in their work they have looked at zinc-sulfate and sodium-sulfate solutions, obtaining reaction times of about  $10^{-9}$  sec for fluctuations of a few thousand molecules.

The method does not itself disturb the reaction under investigation, so Yeh and Keeler hope to collaborate with colleagues in the Livermore biomedical department to study rapid reactions in biochemical systems, such as those involving enzymes.

### **Columbia Builds Meson Factory From Nevis Synchrocyclotron**

Columbia University is converting the 18-year-old 384-MeV synchrocyclotron at its Nevis Laboratories to raise the energy to between 500 and 600 MeV and increase the internal beam current from about 1 microampere to 10–50 microamperes. A new long-duty-factor external beam of 5–40 microamperes is expected to be used for most experiments and will produce



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1.5:1



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**HIGH-RESOLUTION X-RAY PHOTOS OF SUN** (top) were taken during solar flare of 8 June with a rocket-borne grazing-incidence telescope that passed soft x rays. Below are  $H_{\alpha}$  photos of corresponding portions taken two hours before flight. Left set shows flare (resolution of 2 arc sec). Middle set

shows plages close to limb. Right set shows loop structure that extends 150 000 km above limb. Work was reported (*Science* 161, 564) by Giuseppe Vaiana, William Reidy, Theodore Zehnpfennig, Leon Van Speybroeck, Riccardo Giacconi (American Science and Engineering).

a flux of pions and muons 100–1000 times the present value. The type of experiments that can be performed with such a meson facility have been described in Louis Rosen's article "Meson Factories," *PHYSICS TODAY*, December 1966, page 21.

James Rainwater is leading the conversion team that began theoretical and model magnet studies in 1965. A \$4.4-million grant from the National Science Foundation supports the work. The group hopes to have most of the final components in place for testing by the end of 1969 or early 1970. Sometime in 1970 the present machine operation will be suspended while the modifications are made. The converted machine should be ready for use in late 1970 or during 1971.

The plans call for retention of the present 2000-ton iron magnet and the main copper excitation coils. Pole iron within 76 cm of the median (beam) plane will be replaced with new iron, which will include a spiral-ridge iron configuration having three-fold symmetry. The resulting strong azimuthal magnetic-field variation should yield strong axial focusing starting at small orbit radius (3–15 cm). It is this feature, along with at least a five-fold increase in the fre-

quency-modulation cycling repetition rate from about 70 per sec to over 300 per sec, which should permit a large time-average current increase.

The field will be about 17 kilogauss near the center where the proton injection frequency is approximately 26 MHz. The azimuthal average of the field near 200-cm radius will be about 19.5 kG, where the proton rotation frequency is near 18 MHz. The azimuthal field variation (flutter) and spiral will be sufficient to assure strong vertical focusing and is expected to be favorable for extraction of over 50% of the internal beam.

The modification will involve a new vacuum chamber, a new rf system, a large increase in the shielding enclosure around the accelerator and new extraction and beam-transport systems. A building extension, which will provide a greatly increased experimental area, is nearly completed.

### **Observing Time Available On Astronomical Satellite OAO-2**

NASA has invited astronomers to apply for observing time on the second Orbiting Astronomical Observatory (OAO-2). The satellite is being prepared for launch later this year; guest observers can use about 10% of the

observation time beginning about two months after the launch.

OAO-2 will carry the Wisconsin Experiment Package (four stellar photometers, one nebular photometer and two scanning spectrometers) and the Smithsonian Astrophysical Observatory Telescope (which is essentially four wide-field television cameras suitable for ultraviolet wavelengths).

For further information, write Mr C. Dixon Ashworth, Program Manager, Astronomical and Solar Observatories, Physics and Astronomy Programs, NASA, Washington, D.C. 20546.

### **IN BRIEF**

A new Naval Research Laboratory–NASA satellite, Explorer 37, is monitoring solar x-ray and ultraviolet emissions. It will help predict major solar flares. Scientists in other countries are invited to receive direct real-time data from the satellite.

A fifth Orbiting Geophysical Observatory is carrying 24 experiments to measure particles and fields both near the earth and in interplanetary space. It is the next to last in the series. □