is even remotely accounted for in any microscopic theory although all, except possibly the "rattling", are probably significant in simple soft and non-spherical fluids. In such a situation machine simulation studies are certainly at their most valuable and challenging.

If there is a coherent theme in these diverse studies it is surely that the hard-sphere model has now come into its own through careful identification of its role as a central mathematical idealization about which the properties of real, soft, sticky and non-spherical molecules can reasonably be expanded. Although this peculiar combination of pictorial simplicity and mathematical abstraction will probably never endear itself to the extreme realist, few will deny that there is much more to it now than the vision of clicking billiard balls which it seemed to conjure up in students and research workers alike not many years ago.—From our Molecular Physics Correspondent.

(Alun Jones)

NUCLEAR PHYSICS

Higher and Higher

NUCLEAR reactions that are caused by the acceleration of heavy ions—usually taken to be any nucleus of mass greater than helium — preferentially excite nuclear states that have a high angular momentum quantum number. The nuclear physics community are slowly but surely realizing that they have a tool in their possession that will enable them to study the properties of these high spin states with much less difficulty than conventional nuclear reactions induced by light particles.

A report in *Physical Review Letters* (**28**, 571 ; 1972) highlights the use of nuclear reactions induced by carbon nuclei to produce excited nuclear states in sodium-23—the only stable sodium isotope. Dr G. G. Frank and colleagues, of the Tandem Accelerator Laboratory, McMaster University, have bombarded a target of carbon-12 with a carbon-12 beam and have observed the protons that have been emitted in coincidence with gamma rays de-exciting nuclear states in sodium-23.

Sodium-23 is a nucleus that has received more than its fair share of attention in the past few years. The positions of the low-lying states have been successfully fitted to a model that assumes that the nuclear core is permanently distorted with the individual nucleons rotating about this core. The resultant nuclear spectrum is therefore composed of several "single particle" states — states where the nucleons outside the core are in nuclear quantum states—but superimposed on each single particle state there is a rotational band that arises from the quantum states of the rotating core. The stable ground state of sodium-23 has an angular momentum quantum number of 3/2 with even parity.

Associated with this state there are other states of angular momentum 5/2, 7/2, 9/2 upwards, with theoretically no upper limit or cut-off to the sequence. In practice, however, above a certain excitation energy in the nucleus the model becomes invalid—because the core breaks up—and the properties of these states increasingly diverge from that predicted by this model known as the unified nuclear model of S. G. Nilsson.

The states of sodium-23 that lie at low excitation energy have been studied extensively but there has been little work on the higher states. These states are important as it is in these states that any breakdown of the theory will become evident.

The work reported by the McMaster team provides proof that the unified nuclear model is applicable for sodium-23 up to an excitation energy of 6.4 MeV in that nucleus. The ^{12}C(^{12}C,p)^{23}Na reaction when induced with carbon ions of 28.2 MeV strongly populates states in sodium-23 that are known to have high values of angular momentum. One of the states that was populated strongly in the experiment lay at an excitation energy of 6.35 MeV and Dr Frank and colleagues show by a measurement and analysis of the angular distribution of the gamma rays that de-excite this state that it has a spin quantum number of 9/2 with odd parity. They also show that this state can be associated with a rotational band based on the state at 2.64 MeV in sodium-23 that is known to have a spin of 1/2 with negative parity. With the identification of this new state, states with spins of 1/2, 3/2, 5/2, 7/2 and 9/2—all members of the same rotational band—have been identified and, as such, enable a critical test of the upper limit of applicability of the model to be made.

Tests of the Nilsson model are either based on the static or dynamic properties of the nucleus. The static properties—such as the positions of the levels and their nuclear moments—are usually not such sensitive tests of the theories as the dynamic properties—lifetimes of the levels, their mode of decay and the multipole components of the gamma rays. It is found that the gamma ray decay rates are particularly sensitive to whether the rotational bands are "pure" —or whether there is an admixture of another band that complicates the simple model. The level positions on the other hand are notoriously insensitive to band mixing and have in the past been taken erroneously as definitive evidence for the existence of a pure band structure in distorted nuclei where the true position in fact differs considerably.

The 6.35 MeV level in sodium-23 is consistent with both static and dynamic properties of a modified Nilsson model —where band mixing is explicitly taken into account. Although the fit to the 6.35 MeV state is not so good as that for the other lower lying states in this band, it is still good by the criteria commonly used to judge whether the Nilsson model is appropriate.

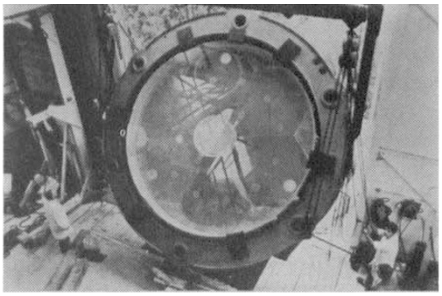
ESO Blank Polished

(Edward Phillips)

POLISHING of the 3.66 m (140 inch) mirror blank for the European Southern Observatory has now been completed by the Reosc optical firm near Paris, and preliminary optical tests are under way. The illustration shows the mirror blank held within its restraining ring during the finishing operations. The fused silica blank was made in 1967 by the Corning glass works in the United States which a year later also made a 3.99 m blank for the Mount Kobau observatory.

The European consortium of France, Germany, Holland, Belgium and Sweden have already installed several small telescopes on the La Silla mountain near the coastal town of La Serena in Chile, which during the past few years has become a Mecca for optical astronomers investigating the relatively unexplored southern skies. In the neighbourhood of La Serena there are also the Cerro Tololo Inter-American Observatory and an observatory initially sponsored by the Carnegie Institution of Washington which will also contain Canadian telescopes.

According to present plans, construction of the building for the 140-inch telescope will begin at La Serena within a year, and the components of the telescope will be ready for shipment from Europe in 1974. First observations are expected in 1975.



Mirror blank for the 140-inch telescope of the European Southern Observatory.