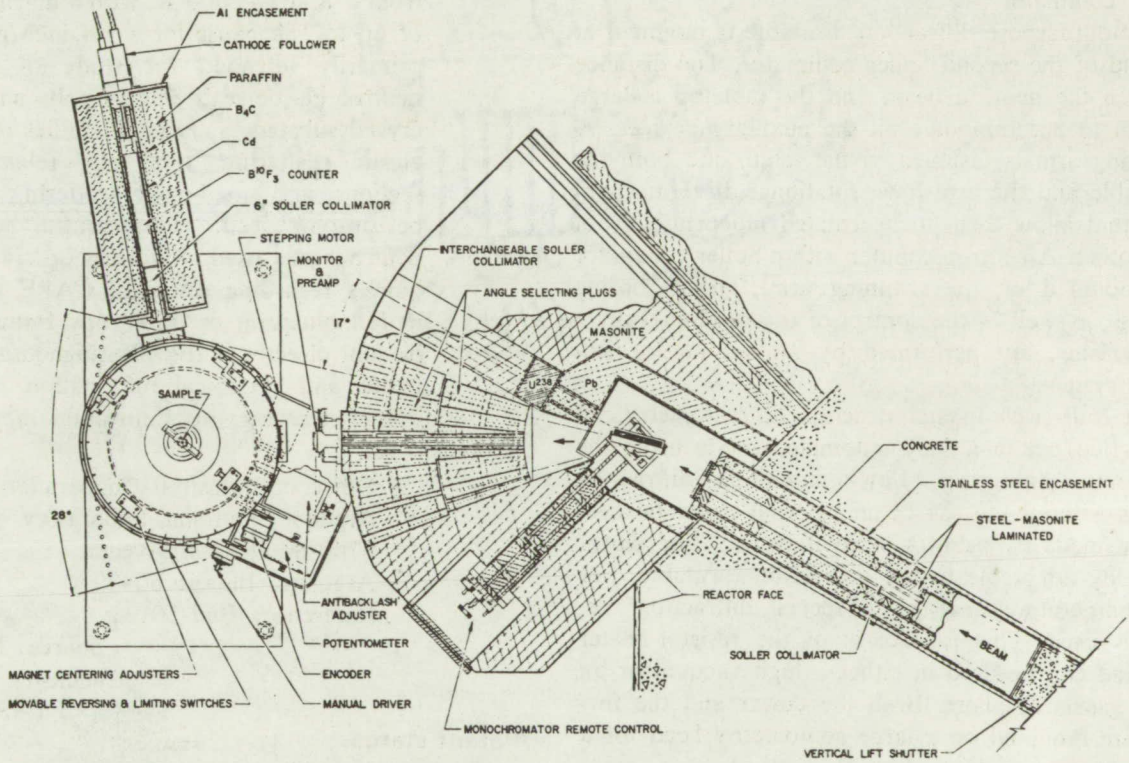
AEC-NASA TECH BRIEF

Neutron Diffractometer Allows Both Magnetic and Crystallographic Analyses



The problem:

To design an automatic double-crystal neutron diffractometer capable of performing both crystal and magnetic structural analyses at temperatures from 1.6°K to 1700°C with or without an external magnetic field of up to 25 k0e.

Because of an interaction between the neutron magnetic moment and the magnetic moment of the atom, the neutron diffraction method can provide information regarding the magnetic spin structure. Neither X-ray nor electron diffraction technique can furnish the magnetic structure data. Also, neutron diffractometry is a powerful tool in the study of crystal structures. Available functioning diffractometers, however, are not readily capable of performing both crystal and magnetic structural analyses.

The solution:

An extensively shielded installation that consists basically of a double-crystal diffractometer with a goniometric turntable and electronic controls for automatic operation. Main auxiliary equipment includes a full two-circle goniometer, a diffraction electromagnet, two types of cryogenic dewars, and two diffraction furnaces. A number of aligning devices are

(continued overleaf)

built in to provide for rapid interchanging of the auxiliary equipment.

How it's done:

The basic diffractometer both collimates and monochromatizes the reactor beam of neutrons. The primary collimation is accomplished with a graphite collimator followed by a Soller collimator. The collimated neutron beam impinges a monochromating crystal mounted with 360° of rotational freedom, ±30° allowance for tilting, and about 1 inch of translational freedom. Control of these alignments is carried out remotely, and with proper adjustment the neutron beam can be monochromated. The monochromator scattering angle can take any value between 17° and 45°. The beam is then recollimated with another Soller collimator.

A multipurpose diffraction turntable is mounted at the end of the second Soller collimator. The distance between the neutron beam and the tabletop is large enough to accommodate all the auxiliary devices. A scanning arm is fastened to the table, and both the turntable and the arm have rotational drive mechanisms that allow them to be rotated independently of each other. A neutron counter with a Soller collimator are mounted on the scanning arm. The recording process, as well as the control of the rotational drive mechanisms, are performed by an automatic electronic system.

The four-circle crystal structure diffractometry can be carried out in a fully automated mode using the two-circle goniometer. Low-temperature diffraction studies without the use of an external magnetic field can be made by using a straight dewar. The dewar is readily adaptable to the diffraction turntable. For high-temperature analysis, a special diffraction furnace is used. This furnace is of the resistor-heater type and can be used in either a high vacuum or an insert gas atmosphere. Both the dewar and the furnace are mounted on a large goniometric head for a full scattering angle study.

For diffraction studies in which the sample is in a magnetic field, a diffraction electromagnet is available. The electromagnet is mounted on a full-circle orienter cradle which can rotate the magnet in the planes vertical to the scattering plane. The electromagnet is also compatible with an angular dewar, which is used for low-temperature studies, and a magnetodiffraction furnace of a type similar to that used for nonmagnetic studies.

Notes:

1. Additional details are contained in the following:
   (a) *Nuclear Instruments and Methods,* vol. 35 (1965) p. 13-33.
   (b) *"A Multipurpose Neutron Diffractometer,"* by Masao Atoji, ANL-6920, Argonne National Laboratory, July 1964. Available from the Clearinghouse for Scientific and Technical Information, Springfield, Virginia 22151, price $3.00, microfiche $0.65.
   (c) CAPE-1239. This automatic, double-crystal neutron diffractometer is used for crystal and magnetic structure analyses at temperatures from 2°K to ~2000°K, with a magnetic field of up to 18k gauss for a 1.4 inch gap. It is primarily intended for study of thermal-neutron elastic scattering by poly- and single-crystal substances. Limited studies of the inelastic scattering, total and related cross sections, and small-angle scattering can also be accomplished. Nonpolarized beams of neutrons are used. Purchase orders and inquiries regarding prices of CAPE packages in full blueprint or microcopy forms should be sent directly to the Clearinghouse for Scientific and Technical Information.
2. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10131

   Source: M. Atoji
   Chemistry Division
   (ARG-191)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
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