

SCIENCE

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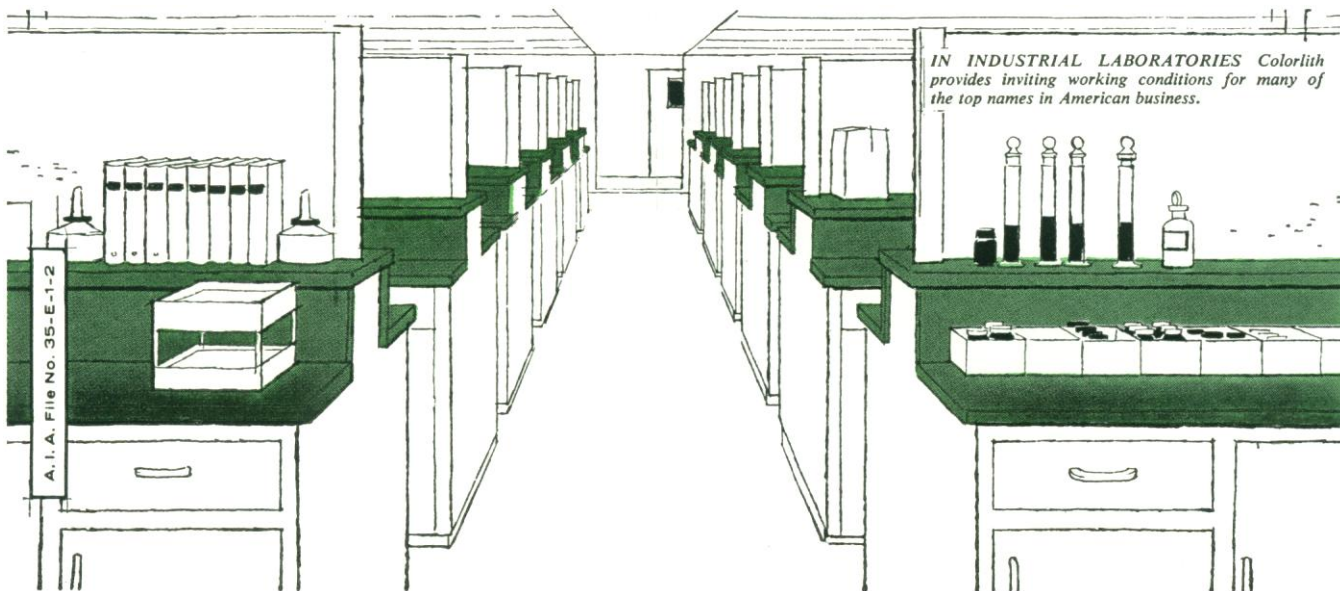
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The place of the Particle Accelerator in Basic Research...

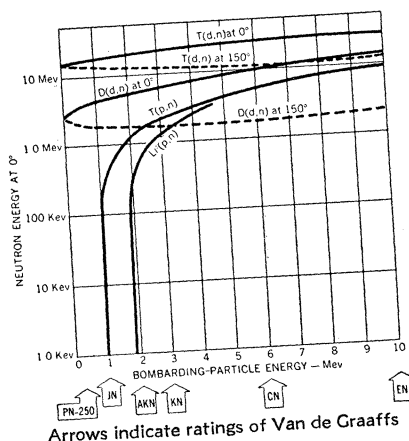
Monoenergetic Neutrons—VII

Since their discovery in 1932, neutrons have been widely used in nuclear bombardment studies. Investigations of excited levels of compound nuclei produced by inelastic collisions with neutrons have enabled physicists to develop models describing these interactions.

Accelerators Gave Control

The early work with neutrons was carried out with radioactive sources. The need for control and precision soon led to the use of particle accelerators as sources of monoenergetic neutrons. Studies were confined to the Mev range from exoergic reactions such as $H^2(d, n) He^3$ and $H^3(d, n) He^4$. Moderation of these fast neutrons was possible, but monoenergetic sources of slow neutrons could not be provided until the development of the atomic reactor in 1942. The subsequent use of monochromators made homogeneous beams of slow neutrons available.

Much work has been carried out with these thermal-neutron beams in measuring energy levels and spacings but, because of the dimensions of the crystal lattice, the maximum energy is confined to the order of tens of electron volts. The development of mechanical choppers has extended the energy range of monoenergetic neutrons to the low kev region, but even this method fails above about 20 kev.



Fast Neutrons Needed

The only useful source of monoenergetic neutrons in the high kev range is provided by endoergic reactions of accelerated charged particles with suitable target nuclei. These reactions have threshold energies of the order of a few Mev. At this energy, the neutrons are emitted with the velocity of the compound nucleus. By varying the energy of the incident beam and the angle of observation, any neutron energy from about 30 kev to several Mev can be obtained. An excellent description of the angular-energy relationship has been given by Hanson, Taschek and Williams¹.

The most suitable reactions for monoenergetic-neutron production are $H^3(p, n) He^3$ and $Li^7(p, n) Be^7$. The former has a threshold of 1.019 Mev and the latter, 1.88 Mev. While the tri-

tium reaction has a broader energy range than the Li^7 reaction, it is difficult to use. The gas must be adsorbed on a suitable metal and care taken to keep the temperature below 100°C. Gas targets have been used but require a thin window between the vacuum system and the gas chamber, producing energy spread in the proton beam. Lithium is a more suitable target material, but above neutron energies of about 600 kev a second neutron group appears.

Variable Monoenergetic Beam Needed

The range of energies available depends on the energy of the incident proton beam, as shown above. The accelerator must have a continuously variable energy if a wide variation of neutron energy is to be obtained.

Neutron energy homogeneity is limited by target thickness, scattering material near the neutron target, and finally, the energy homogeneity of the proton beam. The former are experimental variables. The latter is an inherent property of the accelerator. Monoenergetic beams from the Van de Graaff® have long been considered to be the most suitable for this type of work, and leading nuclear physics laboratories throughout the world are now using Van de Graaffs built by High Voltage Engineering Corporation.

References.

1. A. D. Hansen, R. F. Taschek, J. H. Williams, *Revs. Mod. Phys.* **21**, 635, 1949.

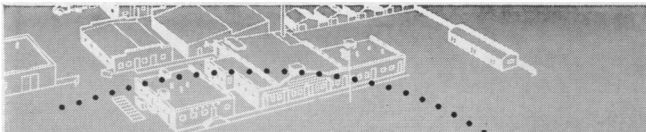
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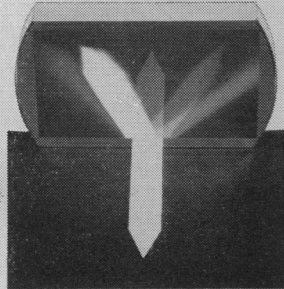
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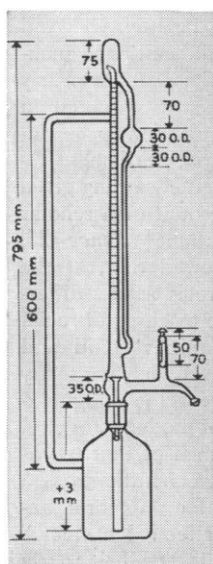
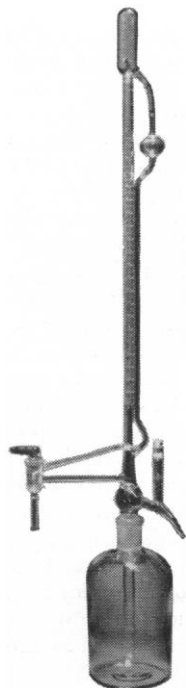
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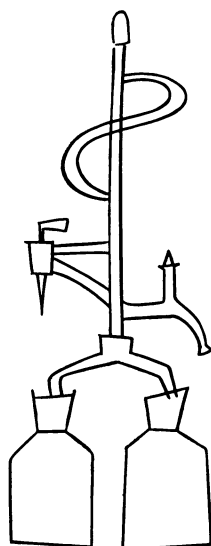
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Letters

Ammi majus

In the article "Effects of 8-methoxypsoralen and ultraviolet light in human skin" [*Science* 127, 878 (1958)], the author, S. W. Becker, Jr., clearly demonstrated the mechanism of 8-methoxypsoralen action. However, I would like to point out that extracts of *Ammi majus* (Linné) have not been "used by the Egyptians . . . for centuries." In fact, the first extracts were made at Cairo University in 1954 [see I. R. Fahmy, A. A. Rahman, R. E. Hakim, *Proc. Pharm. Soc. Egypt Sci. Ed.* 38, 67 (1956)].

Only the cremocarps (tiny fruits) of *Ammi majus* have been dispensed, by the nomadic Berberian tribe of Beni-Shoeib, dwelling in the North African desert, who furnished them powdered in order to disguise the origin of the drug, which was called in Berberian "Atrillal" or the "bird's foot," due to the shape of the umbel that carries the cremocarps.

As reported by Ibn El Bitar (13th century), the secret was finally disclosed, and El Sherif (sixth century) was the first physician to administer these powdered cremocarps for leucoderma in a rather rational way. Dawood El Antaki (17th century), El Rashidi (19th century), and Maimonides all wrote extensively on this drug and its administration, but nowhere is there any mention of "extract" of the plant or its cremocarps.

RAOUF E. HAKIM

M. D. Anderson Hospital,
Houston, Texas

Raouf Hakim's statements are correct. My choice of the term *extract* was a poor one; I meant crude preparations of the *Ammi majus* plant. The first true extracts were those prepared at Cairo University in 1954.

S. W. BECKER, JR.

Whiting Clinic, Whiting, Indiana

Science Education

Science [127, 852 (1958)] reported the very important recommendations of the 1958 Parliament of Science. All scientists will recognize that several widely diverse aspects of our total educational problem were well discussed and helpfully reported by these meetings sponsored by the AAAS.

May one reader note, however, the existence of evidence in support of the view that those recommendations nevertheless essentially fail to come to grips with one problem which some observers now consider the central and most urgent of all our educational problems? I refer to the hardest of all tasks—getting more and

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