The absolute neutron intensity was determined using a proton recoil ionization chamber[1] (4 cm in diameter, 16 cm in length, 1-mm wall thickness of a special aluminum alloy). This was filled to 20 atmospheres pressure with highly purified methane and gave electron collection.

Table I shows the results for three materials and it can be seen

TABLE I. Comparison of the results for three materials.

Scatterer	Inelastic scattering cross section (barns)	Total cross section (barns)	Energy of γ-ray (Mev)	Observation of same excitation level by other methods (Mev)
Magnesium	1.0 ± 0.15	2.2	1.35 ± 0.1	1.38[2] 1.32[3] 1.36[4,5]
Sulfur	0.44 ± 0.06	2.5	2.35 ± 0.1	2.25[3]
Fluorine (polytetrafluoroethylene)	0.62 ± 0.1	2.0	1.3 ± 0.1	1.6[6]

that the γ-ray energy compares well with that obtained by other methods. A test with a carbon scatterer showed no significant effect (inelastic cross section $<6\times 10^{-3}$ barn).

It is of interest to note that in the case of magnesium the cross section of inelastic scattering is approximately half the total cross section at this energy.

Investigations are now proceeding on materials which emit more than one γ-ray line. We wish to express our gratitude to Professor Lord Cherwell for his interest in the work and for the facilities afforded to us.

* We cannot exclude the existence of γ-rays from the d-d reaction which has been discussed by several authors: these would be caused by an excited state of He^3 or H^3 which theoretically is extremely unlikely. However, from a measurement of the number of γ-rays caused by inelastic scattering in the target material itself, we can give an upper limit of 2.5 γ-rays per 1000 neutrons from such a reaction.

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Optical Effects in Bulk Silicon and Germanium

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PURE bulk silicon and germanium are highly transparent to infra-red energy of wave-lengths greater than their photoelectric long wave limits, i.e., 1.2×10^{-4} cm for silicon and 2.2×10^{-4} cm for germanium.[1] As examples of the transmission through thick samples it may be noted that a germanium slab, part of a standard high back-voltage melt, and of thickness 6.0 mm showed very little absorption in the wave-length range from 2 microns to 6.5 microns. A sample of high purity Du Pont silicon, of thickness 5.2 mm, showed little absorption in the wave-length range from 1.2 microns to 6 microns.

The high transparency suggested the measurement of the refractive indices by the prism method. Two prisms were made, one of silicon and the other of germanium. The silicon used was part of a commercial Electromet melt, with a purity of 99.8 percent. Samples of Du Pont silicon that have since come to hand have a lower impurity content. The germanium used was part of a standard high back-voltage melt, and is typical of the purest germanium now available. From spectrochemical tests the total impurity content is estimated as less than 0.01 percent.

Measurements of the prism angle were made with a Gaertner spectrometer equipped with a Gauss eyepiece. Measurements of the angle of minimum deviation were made with the aid of a lead sulfide photo-conducting cell fitted in the eyepiece holder of the spectrometer. The procedure consisted in isolating a narrow spectral band with a Perkin-Elmer monochromator; focusing this energy on the entrance slit of the Gaertner spectrometer, and adjusting the telescope angle so that on rotation of the prism table the photo-cell response indicated minimum deviation.

TABLE I. Silicon: Prism angle 11° 24′ 7″.

λ	n
1.05×10^{-4} cm	3.565
1.10	3.553
1.20	3.531
1.40	3.499
1.60	3.480
1.80	3.466
2.00	3.458
2.20	3.451
2.40	3.447
2.60	3.443

TABLE II. Germanium: Prism angle 17° 6′ 30″.

λ	n
1.80×10^{-4} cm	4.143
1.85	4.135
1.90	4.129
2.00	4.116
2.10	4.104
2.20	4.092
2.30	4.085
2.40	4.078
2.50	4.072
2.60	4.068

The range of measurements is limited on the short wave side by absorption in the prism, and on the long wave side by absorption in the glass of the optical system.

The results of the measurements of refractive indices are shown in Tables I and II.

Consideration of the errors involved in the settings from which the indices were calculated indicates that the values above are accurate for the samples tested to within a few tenths of one percent. Some qualitative tests on germanium at λ 1.8×10^{-4} cm showed a definite increase in refractive index with increasing temperature.

It is to be noted that these values of refractive index for bulk germanium are somewhat lower than we obtained for evaporated films by interference methods.[2] A review of the data on thin film measurements indicates that a possible cause of the discrepancy lies in the assumption of equal densities for the evaporated films and the bulk material.

The high transparency and high refractive indices make possible the construction of unique optical elements for infra-red use. As an example, a plano-convex lens of germanium was made. The radius of curvature of the convex side of this lens is 3.52 inches. The calculated focal length, using the refractive index of 4.1 at 2 microns, is 1.13 inches. This checked well with the experimentally determined focal length. The F-number of this lens is 1.5. The F-number of a glass lens of identical geometry is 9.5.

A further property of these lenses is that they are opaque to visible and ultraviolet light.

As a consequence of the high refractive indices, the reflection losses for windows or lenses of Si or Ge are high, amounting roughly to 50 percent of the incident beam. Such losses may be reduced by the usual non-reflecting film technique. As an example, the transmission of a germanium window was increased from 43 percent to 90 percent of the incident energy at 4 microns by films of selenium on the two surfaces of the window.

[1] This transparency was observed independently by M. Becker and H. Y. Fan, Bull. Am. Phys. Soc. **24**, 29 (No. U5) (1949).

[2] W. H. Brattain and H. B. Briggs, Phys. Rev. **75**, 1705 (1949).

Erratum: Short Range Alpha-Particles from Fluorine and Lithium Bombarded by Protons

[Phys. Rev. **75**, 1756 (1949)]
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AN error was made in the calculation of the energy of the excited state of Be^8 from observation of the short range alpha-particles in the $Li^7(p\gamma)Be^8$ reaction. The emission of alpha-particles of energy 1.38 ± 0.08 Mev at 104° with the incident proton beam of energy 0.44 Mev requires an energy release in the break-up of Be^8 of 3.0 ± 0.2 Mev. The energy of the excited state is 2.9 ± 0.2 Mev instead of 2.6 ± 0.2 Mev as previously given.