SUMMARY

This thesis deals with the measurement of the differential elastic scattering cross sections of the elements lead, mercury, tungsten, antimony, selenium and zinc for 14-MeV neutrons in the angular range from about 15° to 90°.

In the introduction in chapter 1 it is pointed out that a knowledge of these cross sections is important in connection with the so-called cloudy crystal ball model. In particular the scattering data for neutrons of intermediate energy (order of magnitude of 10 MeV) are a direct and sensitive test for the optical model, since the theory is directly applicable to the elastic scattering of neutrons of not too low energy.

In chapter 2 a critical survey of the methods for measuring the above cross sections is given. From a discussion of the advantages and disadvantages of the different methods and geometries we concluded that ring-shaped scatterers and a small spherically-shaped detector should be used for the scattering measurements with 14-MeV neutrons. The absolute values of the cross sections could be evaluated without a knowledge of the neutron intensity and the detector sensitivity. With a view to the calculation of the cross sections and the necessary corrections, torus-shaped scatterers were used. The spherical shape of the detector offers the advantage that the detector-sensitivity is non-directional.

A description of the apparatus is given in chapter 3. The T(d,n)²He reaction was used as the neutron source. The angular distribution of the energy and the anisotropy were calculated from the kinetics of the reaction. The elastically scattered neutrons were detected by way of recoil protons, originating in an organic (spherically-shaped) scintillator (5 g/l terphenyl in xylene). The scintillation detector was biased in such a way that inelastically scattered neutrons and gamma rays were not detected. A proportional counter filled with borontrifluoride served as the neutron monitor.

Chapter 4 deals with the calculation of the cross sections and the corrections. The cross sections were first calculated with some simplifying assumptions, caused by the finite angular uncertainty. The following extension of the neutronic treatment to elastically scattered neutrons was a direct and sensitive test for the optical model, since the theory is directly applicable to the elastic scattering of neutrons of not too low energy.
some simplifying assumptions. Subsequently the necessary corrections, caused by these simplifications, were calculated separately. The following effects were considered: 1) exponential attenuation of the neutrons in the scatterer. 2) energy loss of elastically scattered neutrons in the lab. system. 3) multiple elastic scattering of neutrons in the scatterer. 4) angular spread due to the finite dimensions of scatterer and detector. The correction for the first effect is the most important one, whereas the determination of the last two effects is inherent with some uncertainty.

A discussion of the results is given in chapter 5. In addition to a very pronounced maximum in the forward direction, the angular distributions of the elastically scattered neutrons show maxima and minima, which tend to smaller angles for heavier nuclei and larger neutron energy. In a first approximation the angular distributions only depend on the mass number of the nucleus and the energy of the incident neutrons and not on the details of nuclear structure. The angular distributions for lead and mercury are practically identical. The qualitative features of the angular distributions for 14-MeV neutrons could be reproduced only roughly by simple Fraunhofer diffraction of neutron waves from an opaque disk of the size of the nucleus. However, a description of the angular distributions by means of the optical model gives much better agreement between theory and experiment. A qualitative discussion of this model is given.