ON CLOSED SHELLS IN NUCLEI

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It has been suggested in the past that special numbers of neutrons or protons in the nucleus form a particularly stable configuration.[1] The complete evidence for this has never been summarized, nor is it generally recognized how convincing this evidence is. That 20 neutrons or protons (Ca^{40}) form a closed shell is predicted by the Hartree model. A number of calculations support this fact.[2] These considerations will not be repeated here. In this paper, the experimental facts indicating a particular stability of shells of 50 and 82 protons and of 50, 82, and 126 neutrons will be listed.

ISOTOPIC ABUNDANCES

The discussion in this section will be mostly confined to the heavy elements, which for this purpose may be defined as those with atomic number greater than 33; selenium would be the first "heavy" element. For these elements, the isotopic abundances show a number of striking regularities which are violated in very few cases.

a) For elements with even Z, the relative abundance of a single isotope is not greater than 60 %. This becomes more pronounced with increasing Z; for Z > 40, relative abundances greater than 35 %, are not encountered. The exceptions to this rule are given in Table 1.

Table 1. Even nuclei with Z > 32 with isotopic abundance greater than 60 .

Element	Abundance (%)	Number of neutrons
Sr^{88}	82	50
Ba^{138}	71.66	82
Ce^{140}	90	82

b) The isotopic abundances are not symmetrically distributed around the center, but the light, neutron-poor isotopes have low abundances. The concentration of the lightest isotope is, as a rule, less than 2%. The exceptions to this rule are listed in Table 2.

It is seen that the violations of these two regularities occur practically only at neutron numbers 50 and 82. Only the case of ruthenium in Table 2, which is not a very pronounced exception, does not fall into one of these groups.

The case of samarium, where the lightest isotope has an isotopic abundance of 3%, is only a bare violation of the rule, and may not seem striking. However, what is extraordinary, the next heavier even isotope of samarium, Sm^{146} with 84 neutrons, which one would expect to find in greater concentration, does not exist at all.