SUPERHEAVY ELEMENTS /SHE/ IN NATURE ?

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High energy heavy ion accelerators operating at several world scientific centers were built mainly to fuse heavy elements and to protract the artificial isotope syntesis toward the region of SHE in the new island of stability centered according to the theory arround Z. 114 and N 184.

Although theory is quite optimistic concerning the existence of SHE, the experiment encountered, at least up to now, insurmountable difficulties, because reactions with heavy ions always include high excitation of the compound nucleus which promptly decays through various channels never reaching the region of SHE. This is why, for more than ten years, atempts are made to find SHE in nature. So far this venture also has been unsuccessful./ref. 1, 2/.

Just because of the forementioned difficulties the paper of Gentry et al /ref.3, 4/, came as a great surprise to the scientific community interested in the field. Supposedly, evidence was found for natural SHE of Z = 126 /and some others/in the study of proton induced L X-rays spectra of monazite-mica inclusions /from Madagascar/ showing giant halos.

An almost immediate response from several experimental groups /ref. 5, 6, 7, 8/using the same experimental techniques showed no evidence of unknown X-rays. It has been reported that in monazite /some of them from Madagascar/ impurities of Rh, Sb, and Te are frequent and their K X-rays coul be mistaken for L X-rays of "unknown" SHE, as well as proton induced gammas from reaction $^{140}Ce/p, n\cdot gamma/^{140}Pr$.To do justice, none of the experimenters after Gentry analyzed "giant halo monazite inclusions" although in ref. 8., Gentry's data were reanalyzed, giving negative results.

It is difficult nowadays to imagine possible processes /in labor tory or nature/ in which SHE could be formed. theoretical estimations of half-lives have been so far too optimistic /long/; most probably half-lives are much shorter. If cosmic processes are the only available sources of SHE, they must be ejected towards the solar system at relativistic speeds and therefore destruct themselves in interactions with solar matter /detector/.Can we recognize these impacts ? So far results are negative, because high energy ordinary heavy /region of Pt-isotopes/ cosmic ray interactions escape unique interpretation /concernig Z/.

Pair creation of SHE and anti SHE in p-p̄ scattering close to treshold could be also difficult to observe due to violent annihilation process. Who knows, it may happen that in a suitable detector this event is characteristic enough to be distinguished from others? So far the production of ^{4}He and anti ^{4}He has been reached in the laboratory.

It is difficult to believe that we will ever acquire first-hand evidence of SHE, but a long lived ancestor in a decay chain or a fission product could be detected. This possibility rises some dim hope that mass spectrometric /ref. 9, 10/ and natural radioactivity studies could reveal evidence for extinct SHE.

This should reanimate the studies of natural radioactivity as well as isotopic abundances. Some recent studies of well known natural radioisotopes like ^{228}Ac and ^{226}Ra /ref. 12, 13/ reveal many previously unknown gamma transitions. The same is true for the very recent study of decay of ^{235}U by Baranov et al /ref. 14/.

It is difficult to believe that we will learn something about natural SHE before extensive and combining efforts of mass-spectrometric and natural radioactivity studies are made. We must learn as much as possible about the distribution of radioactivity and variation of isotopic abundances in an ample set of different materials occuring in nature.

References:

1. Flerov G.N., in "Future of Nuclear Structure Studies", Proc. of a Panel, Dubna, 1 - 3 July, 1968.
2. "Super-Heavy Elements Theoretical Predictions and Experimental Generation", Proc. of 27th Nobel Symposium, Ronnery, Sweden, June 11 - 14, 1974, Physica Scripta 10 A /1974.
3. Keller Q.L., Comments Nucl. Part. Phys. 6,143 /1976/.
4. Gentry R.V., Cahill T.A., Fletcher N.R., Kaufmann H.C. Medsker L.R., Nelson J.W., Flocchini R.G., Phys. Rev.Lett. 37,11 /1976/.
5. Bosch F., El Goresy A., Krätschmer W., Martin B., Povh B., Nobiling R., Traxel K., Schwalm D., Z.Physik, 280,39 /1977/
6. Fox J.D., Courtney W.J., Kemper K.W., Lumpkin A.H., Fletscher N.R., Medsker L.R., Phys. Rev. Lett. , 37,629 /1976/.
7. Stephan C., Epherre M., Cieslak E. Sowińki M., Tys J., Phys. Rev. Lett. 37,1534 /1976/.
8. Wölfli W., Lang J., Bonani G., Suter M., Stoller Cr., Nissen H.V., J.Phys. G , 3,L33 /1977/.
9. Lavruhina A.K., "Jadernie reakcii v kosmičeskih telah", "Nauka", Moskva 1972.
10. Lewis R.S., Srinivasan B., Anders E., Science, 190,1251 /1975/.
11. Anders E., Higuchi H., Gros J., Takahashi H., Morgan J.W., Science, 190,1262 /1975/.
12. Horen J.D., Nuclear Data Sheets, 17,367 /1976/.
13. Hachem M.A., C.R.Acad.Sci., Paris, 281,45 /1975/.
14. Baranov S.A., Šatinskij V.I., Zelankov A.G., Plečin V.A., "Tezisi dokladov XXVII soveščania po jadernoj spektroskopii i strukture atomnovo jadra", Taškent, 22 - 25 marta 1977, p.122 "Nauka", Lenjingrad 1977.