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DECLARATION OF INTEREST

FOR ISOLDE 3

STUDY OF LIGHT NEUTRON-RICH NUCLEI

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Our knowledge of the behaviour of nuclear structures rests on the study of a limited sample of nuclei, at or near the valley of β-stability. As such, it is a biased sample since the ratio of neutron to proton numbers in the nuclei studied is centered around the value most favoured by the symetry effects.

The proponents have in the past been engaged in a program studying light neutron rich nuclei either at the Orsay Tandem(1) or at the PS(2).

They would like to stress the important perspectives that could be opened by an ISOLDE III facility at SIN for that field of research.

This is due to the following reasons :

1) valuable quantitative information can be gained at low energy accelerators by other methods such as heavy-ion induced compound-nucleus reactions e.g. (^{18}O,2p) or exotic transfer reactions e.g. (^{18}O, ^{22}O). However both are presently reaching the limits of practicability, because of declining cross sections for increasing neutron-rich nuclei. In that context the successful measurement of the mass of ^{15}B via ^{48}C (^{18}O, ^{15}B) ^{51}V (3) after several failures, gives evidence of the difficulties now encountered. Other methods like deep inelastic heavy ion collisions and heavy-ion induced fragmentation so far only characterize the existence of nuclei. If one modifies them to measure parameters such as mass excesses or half lives, they will be much less efficient than the technique of high-energy proton-induced fragmentation + mass spectroscopy.

2) the possibilities of on line mass separation have in the past been exploited mostly for the alkali elements (Li, Na, K) for no other reason than the fact these could be produced in high enough yields and also with a good purity.

Various parameters can be measured and already have been for the light alkali elements : mass excess, half lives, excitation energies... Coïncident $\gamma\gamma$ measurements allow a reconstruction of level schemes ; β-delayed n, 2n (and even 3n in the case of ^{11}Li) emission are studied.

At least two major results have been obtained in these studies :
i) the discovery by our collaboration of a new deformation region for nuclei with N$\sim$20 (4) ii) the observation that β-delayed multiple neutron emission is a sizable and general process for very neutron rich isotopes (5).

As already pointed out, there is no nuclear physics reason for studying Z=11 rather than other elements. Indeed, the new island or deformation around N=20 should be further documented by studying Z=9, 10, 12 and 13.

It is only due to the limited efficiency of atomic diffusion and ionization for other elements (e.g. F, Ne, Mg, Al) that studies so far have concentrated on Na and other alkali elements. An increased beam intensity would compensate for the low efficiencies and should allow the study of a wider variety of elements, allowing a more systematic mapping of nuclear properties far from the valley of stability. One should note that even if the ionization is not very Z - selective for non-alkali elements, spectroscopic techniques restore that selectivity e.g. through $T_{1/2}$ measurements.

3) At last, in a few cases, an increased ion production would be valuable even for alkali isotopes. For instance, only an upper limit of $P_{3n} \lesssim 10^{-4}$ has been measured for ^{31}Na. An increase of ion production by some two orders of magnitude would most probably allow the observation of this very exotic process.

An experimental program would at least include :

- a systematic study and analysis of γ ray activities for a large number of light elements.

- Q_β measurements resulting in a typical 50 keV uncertainty on mass values.

- observation of β delayed α emission from isotopes with very large neutron excess.

- systematic studies of J^π values for low-lying excited states through $\gamma\gamma$ coincidences and angular correlation experimental methods.

- systematic study of β-delayed multiple neutron emission by γ detection techniques.

Most of these studies can be greatly helped by the observation of the time parameter which characterizes the β decays. This calls for the availability of a pulsed proton beam. On the other hand coincidence work benefits from a continuous beam. Therefore we would value a great versatility in the time characteristics of the part of the SIN beam made available to ISOLDE 3.

references:-

1) F. Naulin, C. Detraz, M. Bernas, D. Guillemaud, E. Kashy, M. Langevin, F. Pougheon, P. Roussel and M. Roy-Stephan.
J. de Phys. Lett 41 (1980) 79 and references there in.

2) C. Detraz, D. Guillemaud, G. Huber, R. Klapisch, M. Langevin, F. Naulin, C. Thibault, L.C. Carraz and F. Touchard.
Phys. Rev. C19(1979) 164 and Nucl. Phys. A 302 (1978) 41.

3) T.S. Bhatia, H. Hafner, J.A. Nolen Jr, W. Saathoff, R. Schuhmacher, R.E. Tribble, G.J. Wagner and C.A. Wiedner.
Phys. Lett. 76 B(1978) 562.

4) C. Detraz, D. Guillemaud, G. Huber, R. Klapisch, M. Langevin, F. Naulin, C. Thibault, L.C. Carraz and F. Touchard. Phys. Rev. C 19 (1979) 164.

5) C. Detraz, M. EPherre, D. GUillemaud, P.G. Hansen, B. Jonson, R. Klapisch, M. Langevin, S. Mattsson, F. Naulin, G. Nyman, H.L. Ravn, A.M. Poskanzer, M. De Saint-Simon, K. Takahashi, C. Thibault, and F. Touchard submitted to Phys. Lett. B