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Author
Lawrence Berkeley National Laboratory

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DISCLAIMER

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88" USER ASSOCIATION NEWSLETTER

Flash!

On January 31, 1984 the LBL 88" Cyclotron ECR source reached a major milestone with the production of the first analyzed beam from an ECR source in the U.S. Since then performance has rapidly improved. The best results for argon as of March 22, 1984 are 32 μA of Ar^{8+}, 13 μA of Ar^{9+}, 3 μA of Ar^{10+}, 1.5 μA of Ar^{11+} and 0.280 μA of Ar^{12+}.

The High Resolution Ball

Introduction

The high resolution ball (HRB), being built by the Diamond-Stephens group, is a system of twenty-one high resolution γ ray detectors, each with a high peak-to-total ratio. Their main function is to resolve complex mixtures of γ rays and to detect low intensity γ rays. In order to do this, the ball has a high "effective" resolution. For example, an excited nucleus made in a (HI, xn) reaction decays through many bands. At the highest spins, their number is such that individual γ rays cannot be resolved at present. At lower spins, the number of bands decreases, and, at around spin 40ħ, a few bands have gathered enough intensity to be resolved. The limit of how many bands (each of low intensity) can be resolved depends on several considerations:

1) A high efficiency and a low background of Compton events are necessary since each γ transition has a low intensity.

2) A high energy resolution increases the probability of separating each γ transition from the other.

3) In a given nucleus, the region where there are many decaying bands, there are several γ rays of the same energy (within the detector resolution), each being most often in a different band. In that case, the usual "double coincidence" will not permit one to isolate each band. A higher "effective" resolution can be achieved with "triple coincidences", since the probability of having a clean "double gate" is considerably (about ten times) higher.

Almost any time a complex system of γ rays has to be resolved or low intensity γ rays have to be detected, use of the HRB system will be advantageous.

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Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720
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Description of the device

The high energy resolution is obtained with germanium (n-type) γ ray detectors. Their efficiency is 20% of that of a 3"x3" NaI detector at 1.33 MeV and their energy resolution is typically 2 keV at that energy. The low background is achieved by suppressing 75% to 80% of the Compton events in the Ge detector; events in which a Compton-scattered γ ray is detected in a shield surrounding the Ge detector are rejected. The shield is basically a cylindrical shell of bismuth germanate (BGO). Bismuth germanate has a density twice as high as that of NaI, and a high effective Z so that a rather small volume (outer diameter 5") is enough to obtain a peak-to-total ratio of about 50% for a γ ray of 1.2 MeV. Figure 1 is an artist's conception of half of the device. A steel holder (not shown), composed of two horizontal ~6 foot diameter rings, supports the three circles of seven detectors each. Each detector can be located at any angle in the horizontal plane and between $\pm 45^{o}$ out of that plane. These 21 detectors can be as close as 5" from the target. This produces such a high efficiency that triple coincidences will be obtained with sufficient statistics during a typical run of about 10 shifts (1 shift = 8 hours).

Present status and first results

We have at the moment seven Ge detectors with their BGO shields. With a beam of 10nA of ^{40}Ar on a Sn target, the double-coincidence Compton-suppressed rate is about 1000/s. Figure 2 shows a coincidence spectrum obtained during a one-day run with the gate shown in the insert. Even with a weak γ ray, very clean coincidence spectra are obtained.

Future plans

Preliminary tests with a prototype show that the peak-to-total can be improved by about 10% if the γ rays backscattered from the Ge detector are caught in a NaI collimator placed in front of the system so that the corresponding event is rejected. We plan to provide such a collimator for each detector. In many cases, an additional trigger allows selection of "good" events. For high-spin studies, the separation of the different reaction products will clean up the γ ray spectra considerably. This will be achieved with a sum spectrometer as shown in Fig. 1. Forty-four elements of BGO form a castle in which each element has about the same efficiency, the total efficiency being about 90%. Holes in the appropriate places will let the Ge detector view the target while the castle will also serve to shield the BGO Compton suppressors from direct γ rays. Other types of trigger detectors such as particle detectors can be used to select events. This can also be done in conjunction with the central castle, from which elements can be removed to accommodate the other detectors if necessary.

The device in its present state has been used for high spin studies, and some reaction studies are planned for which neutron damage to the Ge detectors is not anticipated. The Diamond-Stephens group is open to suggestions for collaborative experiments.

(We thank Dr. Claude Lyneis, Project Manager of the ECR source, and Dr. Marie-Agnes Stephens of the Diamond-Stephens group for their contributions to this issue.)

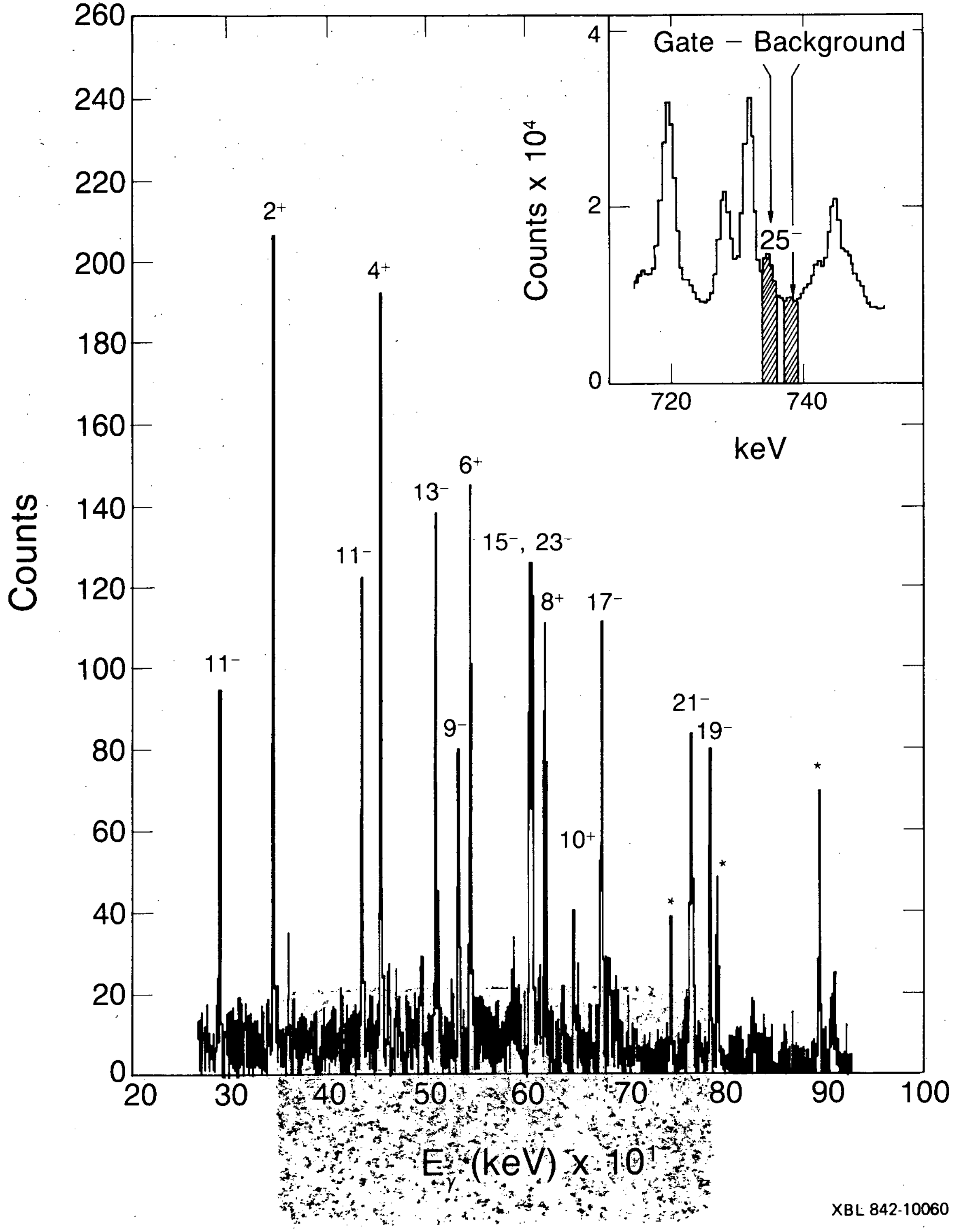

Fig. 2 Coincidence spectrum with background subtracted, gated by the line $25^- \rightarrow 23^-$ shown in the insert, for the reaction $^{40}Ar + ^{120}Sn$ at 175 MeV. The absolute intensity of that line, which was unknown, is 2% in the spectrum. The initial J^π of transitions not yet assigned above 25^- are marked by an asterisk.

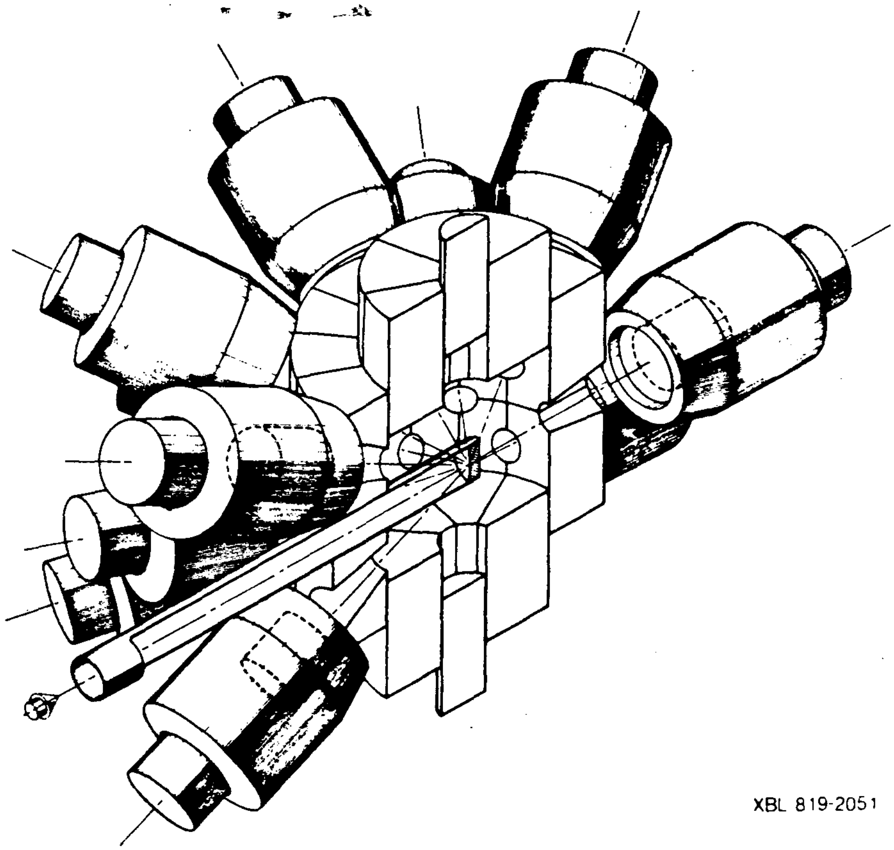

Fig. 1 Artist's drawing of half of the High Resolution Ball.

USERS ASSOCIATION
Bldg. 88, Rm. 227
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720