Multiple Coulomb Excitation Techniques

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The following three techniques have been developed that exploit Gammasphere to study high-fold γ-ray events providing an enormous advance in selectivity and sensitivity for Coulomb excitation studies.

1) CHICO detects the ions recoiling out of a thin target in coincidence with the deexcitation γ-rays by Gammasphere. This allows detection of the highest possible spin following Coulomb excitation, e.g spin 40 in ^{238}U [1]; it provides useful low-fold information, and the measured γ-ray yields provide a reliable and sensitive measure of the $E\lambda$ matrix elements. The disadvantage is that the γ-ray lines are slightly Doppler broadened due to the finite granularity of Gammasphere. This broadening will be reduced by a factor of four using Gretina plus SuperCHICO. For example, see [2,3,4,5,6].

2) The thick-target unsafe Coulonb excitation technique developed by Ward [7], does not suffer from Doppler broadening of the γ-ray lines but it is limited to study of longer lived states, i.e. lower spin states, due to the finite stopping time of recoiling ions in the thick target. High-fold events in Gammasphere are used to select collective bands and the γ-ray lines for states that decay after the recoils stop in the thick target to achieve the full energy resolution. This approach complements the CHICO thin-target approach and is ideal for mapping quadrupole and octupole rotational bands up to spins ≤ 30 in actinide nuclei; but it is insensitive to low fold decay paths and the γ-ray yields cannot be used to determine reliable $E\lambda$ matrix elements. We have used this technique to map quadrupole and octupole nuclear rotational bands in actinide nuclei [8,9,10].

3) We developed a new technique by combining the thick-target Coulomb excitation technique with detection of backscattered particles using CHICO. This combines the excellent γ-ray energy resolution obtained for stopped ions in the thick target, with the background suppression and selectivity provided by requiring coincidence with a backscattered heavy ion. This technique applied to a Coulomb excitation study of ^{235}U obtained 300 resolved γ-ray transitions dramatically increasing knowledge of its structure [11]. Another successful application was a study of ^{242}Am [12,13].

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