

Mass Measurements with the CSS2 & CIME cyclotrons @ GANIL

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The mass of a nucleus and hence its binding energy has capital importance for nuclear physics and astrophysics. This quantity defines for instance the boundaries of existence of exotic nuclei lying far from the line of stability. It also provides detailed information about the interaction of the nucleons inside the nucleus.

The study of exotic nuclei requires the production of low cross-section and short-lived species and the development of state-of-the-art techniques to measure their properties such as their masses. Two direct techniques based on the use of cyclotrons as high-resolution mass spectrometers are currently being used at GANIL.

One of these techniques is based on the measurement of the Time of Flight (ToF) of the ionised nuclei along their spiral trajectory inside the CSS2 cyclotron. Ions with different mass/charge ratios (m/q) arrive at the detector with a delay proportional to their m/q difference:

$$\delta (m/q)/(m/q) = \delta t/t$$

The mass resolution of the method depends on the length of the path, which makes the cyclotron an excellent tool for the ToF technique. In the case of the CSS2 cyclotron at GANIL, the ions cover a spiral path of the order of a kilometre in 50-100 μ s before impinging into the detector. The new results on the masses of ⁶⁸Se and ⁸⁰Y, which have been measured with CSS2 with relative precision of $\sim 4 \cdot 10^{-6}$ and $2 \cdot 10^{-6}$ respectively, will be presented.

The CIME cyclotron at GANIL offers the possibility to accelerate a wider range of exotic and reference masses. The basis of this new technique (currently under development) is the sweeping of the radio frequency of the cyclotron covering a range of frequencies wide enough to allow the acceleration of ions with larger m/q differences than with CSS2. The unknown masses are obtained from a calibration of the frequency of acceleration of the reference ions:

$$\delta (m/q)/(m/q) = -\gamma^2 \delta f/f$$

Tests of this technique, using stable nuclei, have been performed and the preliminary results from recent data will be presented.

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