Contribution ID: **131** Type: **Invited Presentation**

First Direct Mass Measurements on Mendelevium with an MRTOF Mass Spectrograph

Tuesday, 30 May 2017 15:00 (15 minutes)

Precision mass measurements of unstable nuclei, providing direct measure of the nuclear binding energy, are invaluable for nuclear structure study and have potential for particle identification of atomic nuclide by the precision mass value. For trans-fermium nuclei, of importance for understanding the shell evolution in heavy nuclear system to inspect mass models toward so-called island of stability and the unique identification during new elements search, the mass measurements require fast measurement time even for such a heavy mass nuclei and high efficiency to tolerate extremely low production yields.
Direct mass measurements of trans-fermium nuclei were, so far, performed for only 6 nuclei of nobelium and lawrencium with the Penning trap mass spectrometer SHIPTRAP [1,2]. Recently we implemented a multi-reflection time-of-flight mass spectrograph (MRTOF-MS) located after a cryogenic helium gas cell coupled with the gas-filled recoil ion separator GARIS-II [3] and performed direct mass measurements of mendelevium isotopes for the first time. Using ^{48}Ca beam on $^{\mathrm{nat}}$Tl target, we produced $^{249-251}$Md by fusion-evaporation reaction and successfully measured those masses including new masses of $^{249-250}$Md with sub-ppm precision. They were extracted as doubly charged atomic ions from the gas cell as well as other actinides such as nobelium and fermium. Combined with known alpha decay Q-value of $^{249-250}$Md, we could newly determine masses of isotopes on the decay chain from bohrium to berkelium.
References:
[1] M. Block {\it et al.}, Nature 463 (2010) 785
[2] E.M. Ramirez {\it et al.}, Science 337 (2012) 1207
[3] P. Schury {\it et al.}, Phys. Rev. C (accepted)

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Session Classification: Breakout 1