A PLASMA ION SOURCE FOR ISOLTRAP

Thomas Guldager Skov
August 9, 2016
Aarhus University
Binding energies:

\[ B(N, Z) = (NM_n + ZM_p - M(N, Z))c^2. \]
Binding energies: \[ B(N, Z) = (NM_n + ZM_p - M(N, Z))c^2. \]

**Nuclear Structure**, nuclear magic numbers.
RELEVANCE OF NUCLEAR MASSES

Binding energies: $B(N, Z) = (NM_n + ZM_p - M(N, Z))c^2$.

Astrophysical processes, e.g. the r-process.

RELEVANCE OF NUCLEAR MASSES

Binding energies: \( B(N, Z) = (NM_n + ZM_p - M(N, Z))c^2. \)

Fundamental Tests, e.g. neutrino mass from \( \beta \)-decay.

S. Eliseev, Addendum to Proposal P-242 to the INTC.
ISOLDE AND ISOLTRAP
ISOLDE AND ISOLTRAP
Trap the nuclides of interest in a Penning trap.

\[ \omega_{\pm} = \frac{\omega_c}{2} \pm \sqrt{\frac{\omega_c^2}{4} - \frac{\omega_Z^2}{2}}, \]

\[ \omega_c = \frac{q}{m} B. \]

Excite the fast cyclotron motion. Time-of-flight measurements of released ions.

Trap the nuclides of interest in a Penning trap.

\[
\omega_\pm = \frac{\omega_c}{2} \pm \sqrt{\frac{\omega_c^2}{4} - \frac{\omega_z^2}{2}},
\]

\[
\omega_c = \frac{qB}{m}.
\]

Excite the fast cyclotron motion. Time-of-flight measurements of released ions.

- ToF is a function of excitation frequency ⇒ spectrum.

SETUP AND RESULTING SPECTRUM

Upcoming ISOLTRAP experiment will measure the masses of $^{131}$Cs and $^{131}$Xe.
Upcoming ISOLTRAP experiment will measure the masses of $^{131}$Cs and $^{131}$Xe.

- Gaseous $^{131}$Xe needs new ionization method $\Rightarrow$ plasma ion source.
- Future reference ion source.
Upcoming ISOLTRAP experiment will measure the masses of $^{131}\text{Cs}$ and $^{131}\text{Xe}$.

- Gaseous $^{131}\text{Xe}$ needs new ionization method $\Rightarrow$ plasma ion source.
- Future reference ion source.

Project stages

- Set up test lab.
- Characterization of the ion source.
- Implementation in ISOLTRAP and test of extraction.
THE PLASMA SOURCE
RESULTS

Voltage (kV) vs. Current (nA) for different pressures (P). The pressure values are as follows:

- P = 0.0007 mbar
- P = 0.00075 mbar
- P = 0.00076 mbar
- P = 0.00077 mbar
- P = 0.00078 mbar
- P = 0.00079 mbar
- P = 0.0008 mbar
- P = 0.00081 mbar
- P = 0.00084 mbar
- P = 0.00089 mbar
- P = 0.0009 mbar

Each pressure level is represented by a different symbol on the graph.
RESULTS

![3D graph showing the relationship between P (mbar), Voltage (kV), and Current (nA). The graph plots data across a range of P (mbar) from 1 to 5.5, Voltage from 3.5 to 5 kV, and Current from 0 to 100 nA. The data peaks significantly at a specific P (mbar) and Voltage value.](image-url)
CONCLUSION

· Nuclear mass measurements are relevant to several fields of research.
· Nuclear masses are determined from TOF-measurements after release from a Penning trap.
· The new plasma ion source will allow for ionisation of gasses inside the ISOLTRAP setup.
Questions?