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Rest Mass of the Fully Stripped Gold Ions

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The mass of an atom is usually expressed as:

$$\mathrm{M(N,Z) = Z * (m_p + m_e) + N * m_n - (BE)_{nucleus} - (BE)_{electrons}} \qquad (1)$$

where N is the number of neutrons, m_p, m_e, m_n are the proton, electron, and neutron rest masses, respectively; and $(BE)_{nucleus}$ and $(BE)_{electrons}$ represent the total binding energies of the nuclear particles and of the atomic electrons, respectively. Atomic mass of the 197 gold is(1):

$$_{79}\mathrm{Au}^{197} \rightarrow \mathrm{M_{Au}} = 196.966548 \pm .000006\mathrm{atmu} = 183.47322\mathrm{GeV}$$

The rest mass of the fully stripped gold ions $\mathbf{M^*(N,Z)}$ is:

$$\mathrm{M^*(N,Z) = M(N,Z) + (BE)_{electrons} - Z * m_e} \qquad (2)$$

Values of the fundamental physical constants as: speed of light **c**, the electron rest mass m_e, the atomic mass in GeV are(2):

$$\mathbf{c} = 299\ 792\mathrm{m/s}$$

$$\mathrm{m_e} = 9.109\ 389\ 7\,(54) \pm 0.59 * 10^{-31}\mathrm{kg} => 0.51099906\mathrm{MeV}$$

$$\mathrm{e} = 1.60217733\,(49) \pm 0.310^{-19}\mathrm{C}$$

$$\mathrm{atmu} = 0.931\ 494\ 32\,(28) \pm 0.3\mathrm{GeV}$$

$$\mathrm{Z * m_e} = 79 * 0.51099906\mathrm{MeV} = 0.0403689257\mathrm{GeV}$$

The binding energy of the electrons from the **K**, **L**, **M**, and other shells could be estimated from the X–ray emission data (2 electrons in the K shell with 8.7 KeV, 8 electrons in the L shell with 13.0 KeV etc.) as:

$$(\mathrm{BE})_{\mathrm{electrons}} = 0.327\mathrm{MeV} = 0.000327\mathrm{GeV}$$

$$\boxed{\mathbf{M^*(N,Z)} = 183.43318\ \mathrm{GeV} = 196.92356\ \mathrm{atmu}}$$

The magnetic rigidity $\mathbf{B}\rho$ for the fully stripped gold ions could be calculated if the energy or momentum are known:

$$\mathbf{B}\rho = \mathrm{p}/\mathbf{Z}\mathrm{e} = \mathrm{m}_{\mathrm{rest}} * \beta\gamma/79\mathbf{c} = \left(\mathrm{m}_{\mathrm{rest}}\sqrt{\gamma^2 - 1}\right) / (79 * \mathbf{c})\,\mathrm{Tm}$$

$$\mathbf{B}\rho\mathrm{Au}^{79} = 7.7451547 * \sqrt{\gamma^2 - 1}(\mathrm{Tm})$$

References

1. A.H. Wapstra and N.B. Cover, Nuclear Data Table 9, 265 (1971).
2. E. Richard Cohen and Barry N. Taylor, Physics Today, August 1992, part 2, pp. 9–14.