

Rest Mass of the Fully Stripped Gold Ions

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The mass of an atom is usually expressed as:

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

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

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

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

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

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

$$c = 299\,792\,458 \text{m/s}$$

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

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

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

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

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:

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

$$M^*(N,Z) = 183.43318 \text{ GeV} = 196.92356 \text{ amu}$$

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

$$B\rho = p/Zc = m_{\text{rest}} * \beta\gamma / 79c = \left(m_{\text{rest}} \sqrt{\gamma^2 - 1} \right) / (79 * c) \text{ Tm}$$

$$B\rho_{\text{Au}^{79}} = 7.7451547 * \sqrt{\gamma^2 - 1} (\text{Tm})$$

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.