H-Units: The H-Kilogram
Universal Mass from the H-Planck Choice

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Abstract

We complete the H-unit system by adopting the H-Planck choice $\hbar \equiv 1$ (exact), which fixes the unit of action, and then defining the H-kilogram such that Newton's gravitational constant $G \equiv 1$ (exact). Mass is thereby fixed by the universal hydrogen hyperfine transition, the speed of light, and the quantum of action. The resulting system is fully cosmically reproducible and yields the mathematically purest possible form of black-hole thermodynamics and quantum gravity equations.

1 Introduction

The H-second, H-meter, and Cosmic Kelvin eliminate Earth-based bias in time, length, and temperature. Mass in SI remains tied to laboratory constants. For truly universal metrology, mass must be defined from cosmic observables plus one natural unit choice. The H-Planck choice $\hbar \equiv 1$ together with $G = 1$ provides exactly that.

2 H-Unit Recap and the H-Planck Choice

The H-second and H-meter are defined from the hydrogen hyperfine transition and $c \equiv 3 \times 10^8$ H-m/H-s (exact).

We adopt the H-Planck convention

$$\hbar \equiv 1 \quad \text{(exact — fixes the unit of action).}$$

The H-kilogram is then defined such that

$$G \equiv 1 \quad \text{(exact — fixes the unit of mass).}$$

3 Consequences for Fundamental Physics

With $\hbar = c = G = k_\text{B} = 1$, the Hawking temperature and Bekenstein–Hawking entropy of a Schwarzschild black hole of mass M reduce to the pristine forms

$$T_\text{H} = \frac{1}{8\pi M}, \tag{1}$$

$$S_\text{BH} = 4\pi M^2, \tag{2}$$

containing *no additional fundamental constants.*

Equations in loop quantum gravity, string theory, and cosmology similarly achieve maximal simplicity.

4 Practical Realisation and Uncertainty

The H-kilogram is realised indirectly through $G \equiv 1$ once the H-second, H-meter, and $\hbar = 1$ are fixed. Current SI measurements of G have relative uncertainty $10^{-5}(CODATA2022)$.

In pure H-unit metrology, G is exact by definition; the uncertainty applies only when converting to or from SI units. Future astronomical tests will improve independent realisations.

5 Comparison with Alternatives

SI mass is defined via $\hbar$ and laboratory apparatus. Planck units fix $G = \hbar = c = 1$ but are not practically realisable. The H-kilogram achieves the same mathematical elegance while remaining anchored to the directly observable 21-cm hydrogen line.

6 Conclusion

With the H-kilogram defined by $G \equiv 1$ in the H-Planck system, all seven SI base units are now derivable from three cosmic observables (hydrogen hyperfine transition, speed of light, CMB spectrum) plus one natural unit choice ($\hbar = 1$).

Earth keeps SI. Space inherits H-units.

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References

[1] P. J. Mohr et al., "CODATA Recommended Values of the Fundamental Physical Constants: 2022," *Rev. Mod. Phys.* **97**, 025002 (2025).