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Plenary — Avik De: The Non-Metricity Gravity Approach

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General Relativity formulates gravitation through spacetime curvature using the Levi-Civita connection, which assumes both vanishing torsion and zero non-metricity. However, alternative geometric descriptions exist within the Geometric Trinity of Gravity. Among these, Non-Metricity Gravity, specifically $(f(Q))$ gravity and its scalar-tensor extensions, attributes gravitational interactions strictly to the non-metricity tensor, setting curvature and torsion tensors to zero while introducing coupled scalar fields to unlock rich, dynamical behaviors.

A crucial feature that makes modified non-metricity theories particularly intriguing is that the affine connection is no longer uniquely fixed by the metric tensor alone. In isotropic and homogeneous spacetimes, such as the FLRW universe, the requirement of zero curvature and zero torsion yields three distinct classes of affine connections. Similarly, applying these geometric constraints to static spherically symmetric systems reveals two independent classes of connections.

These non-trivial connection classes transform the study of non-metricity gravity from a simple metric modification into a deep structural probe of spacetime geometry. Depending on which connection branch is realized, the underlying non-metricity scalar Q acquires completely different dynamic expressions. This mathematical degree of freedom allows identical spatial metrics to yield dramatically different field equations, influencing late-time cosmic acceleration, inflationary dynamics, and black hole or stellar solutions. This work highlights how exploring these distinct connection choices opens up compelling new pathways for understanding fundamental gravity.