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Rethinking Gravity: From Torsion and Nonmetricity to Black Holes and Cosmology

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Einstein's theory describes gravity through spacetime curvature, but more general gauge-theoretic frameworks allow spacetime to carry torsion and nonmetricity as well. I will first introduce metric-affine gravity as a framework in which curvature, torsion, and nonmetricity have distinct geometric roles, and discuss the theoretical consequences of these structures, including their relation to hypermomentum and intrinsic properties of matter such as spin, dilation, and shear. I will then turn to black holes in theories with torsion and/or nonmetricity, including scalarised black holes and the gravitational spin-orbit effect. Finally, I will discuss cosmological models with non-Riemannian geometry, focusing on FLRW backgrounds and the propagation of an additional massive spin-2 mode associated with torsion.

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