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J. J. Sakurai Prize: Harmony of Scattering Amplitudes: From Gauge Theory to Supergravity

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As explained in the two previous talks by Lance Dixon and David Kosower, on-shell methods have had an important impact on our understanding of scattering amplitudes and their application to collider physics. In this talk I will describe examples where these ideas have also had impacts in more theoretical areas. The first example shows how these methods have led to the construction of all quantum corrections to specific scattering amplitudes in maximally supersymmetric gauge theory with a large number of color charges. An active area of current research is to do the same for more intricate generic amplitudes of the theory. A second example shows how on-shell methods have uncovered new algebraic structures in gauge-theory amplitudes that have applications to quantum gravity. The advances make it possible to carry out computations in quantum gravity that would have been hopeless with more traditional Feynman diagram methods and to elucidate a remarkable connection between gauge and gravity theories. The results from these investigations have renewed hope that highly supersymmetric gravity theories may be ultraviolet finite, contrary to the prevailing wisdom.