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String Theory in Greater Paris

Rencontres Théoriciennes

"Supergravité, théorie des cordes et théorie M"

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Conformally soft photons and gravitons

The four-dimensional S-matrix will be reconsidered as a correlator on the celestial sphere at null infinity. Asymptotic particle states can be characterized by the point at which they enter or exit the celestial sphere as well as their $SL(2, \mathbb{C})$ Lorentz quantum numbers : namely their conformal scaling dimension and spin $h \pm \bar{h}$ instead of the energy and momentum. This characterization precludes the notion of a soft particle whose energy is taken to zero which plays an important role in the conventional formulation of quantum field theory scattering amplitudes. We propose that in this new formulation it should be replaced by the notion of a conformally soft particle with $h = 0$ or $\bar{h} = 0$. For photons and gravitons we explicitly construct conformally soft $SL(2, \mathbb{C})$ currents with dimensions $(1, 0)$ and $(2, 0)$ respectively and identify them with the generators of a $U(1)$ Kac-Moody symmetry on the celestial sphere and celestial conformal symmetry. BMS supertranslations are generated by a spin-one current whose OPE relation looks quite unusual from the celestial CFT_2 perspective but is equivalent to the leading soft graviton theorem and may usefully constrain celestial correlators in quantum gravity.

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