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Gapless Bosonic Excitation without symmetry breaking: Novel Algebraic Spin liquid with soft Gravitons CENKE XU, UC Berkeley — A novel quantum ground state of matter is realized in a bosonic model on three dimensional fcc lattice with emergent low energy excitations. The novel phase obtained is a stable gapless boson liquid phase, with algebraic boson density correlations. The stability of this phase is protected against the instanton effect and superfluidity by self-duality and large gauge symmetries on both sides of the duality. The gapless collective excitations of this phase closely resemble the graviton, although they have a soft $\omega \sim k^2$ dispersion relation. There are three branches of gapless excitations in this phase, one of which is gapless scalar trace mode, the other two have the same polarization and gauge symmetries as the gravitons. The dynamics of this novel phase is described by a new set of Maxwell's equations. The defects carrying gauge charges can drive the system into the superfluid order when the defects are condensed; also the topological defects are coupled to the dual gauge field in the same manner as the charge defects couple to the original gauge field, after the condensation of the topological defects, the system is driven into the Mott Insulator phase. In the 2 dimensional case, the gapless soft graviton as well as the algebraic liquid phase are destroyed by the vertex operators in the dual theory, and the stripe order is most likely to take place close to the 2 dimensional quantum critical point at which the vertex operators are tuned to zero.

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