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Quantum Gravity and Quantum Cosmology

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Our large scale classical universe originates in the small scales of a quantum mechanical big bang. A quantum theory of the big bang is the subject of quantum cosmology. The theory consists of two parts: First, a quantum theory of spacetime geometry coupled to matter - a quantum theory of gravity. Second, a theory of the universe's quantum state. Such a combination predicts probabilities for the different large scale classical spacetimes the universe might have. It thus gives probabilities for what we observe. In particular it gives probabilities for the large scale homogeneity and isotropy, for the number of efolds of inflation, for the fluctuations we measure in the CMB and the distribution of galaxies, and, in a landscape where they can vary, for constants like the cosmological constant. This talk will illustrate how this works in a few simple models based largely (but not exclusively) on semiclassical quantum gravity and the no-boundary wave function of the universe of Hawking and his collaborators. 100 years after its inception Einstein's general relativity has significant implications not only for the very large but also for the very small.