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EINSTEIN EQUATIONS: PHYSICAL AND MATHEMATICAL ASPECTS OF GENERAL RELATIVITY

LECTURE

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Inflation and pre-inflation: the present status and expected discoveries

4 lessons of one hour each

I shall outline the two simplest classes of phenomenological models of slow-roll inflation in the early Universe based either on scalar fields in General Relativity or on modified f(R) gravity, their relation and basic assumptions necessary for their realization. At the present state-of-the-art, the simplest inflationary models from these classes producing the best fit to all existing astronomical data requires one, maximum two dimensionless parameters taken from observations only. The main discoveries expected for these models in future are discussed, too. Among them the most fundamental are primordial quantum gravitational waves generated during inflation. It is argued that the measured value of the slope n_s-1 of the primordial scalar power spectrum, under the additional assumption of the absence of new fundamental scales both during and after inflation, implies small, but not too small tensor-to-scalar ratio r~3(1- n_s)^2 ~ 0.004 or even more, similar to that in the original f(R) = R+R^2 inflationary model (Starobinsky, 1980). Another possible discovery is related to small local features in the CMB temperature anisotropy power spectrum in the multipole range l=(20-40) beyond which new physics during inflation may be hidden. Also new physics acted during the last stage of inflation could show itself would primordial black holes be found, in particular, through direct observations of their coalescence in binary systems at present. Since inflation, as a metastable quantum state, had finite life-time (and we can measure difference in its duration in terms of the number of e-folds between different points of space with remarkable accuracy), it is well possible to think what might be before it. In the models considered, the most generic predecessor of inflation is an anisotropic and inhomogeneous space-time near a generic space-like singularity. Conditions needed for the onset of inflation from such a state will be discussed. Since this process is generic, too, for inflation to begin inside a patch including the observable part of the Universe, causal connection inside the whole patch is not necessary. However, it becomes obligatory for a graceful exit from inflation in order to have practically the same number of e-folds during inflation inside this patch.