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The Cauchy Problem for the Einstein Equations and Gravitational Radiation

In Mathematical General Relativity (GR) the Einstein equations describe the laws of the universe. This system of hyperbolic nonlinear pde has served as a playground for all kinds of new problems and methods in pde analysis and geometry. An interesting feature of GR is the phenomenon of gravitational radiation. In 2015, Advanced LIGO measured gravitational waves for the first time. Two black holes merging are sending out gravitational waves, which are nothing else but the fluctuation of the spacetime curvature. In order to understand this radiation as well as the dynamics of the gravitational field, we have to investigate the Cauchy problem for the Einstein equations. I will talk about geometric-analytic results on gravitational radiation and the memory effect of gravitational waves. We will connect the mathematical findings to experiments. I will also address recent work with David Garfinkle on gravitational radiation in asymptotically flat as well as cosmological spacetimes.