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Birkhoff normal form for nonlinear wave equations

Many theorems on global existence of small amplitude solutions of nonlinear wave equations in $\mathbb{R}^n$ depend upon a competition between the time decay of solutions and the degree of the nonlinearity. Decay estimates are more effective when inessential nonlinear terms are able to be removed through a well-chosen transformation. Additionally, most physically relevant wave equations can be formulated as Hamiltonian PDEs, and the analysis of their solutions can be considered in this context. In this talk, we construct Birkhoff normal forms transformations for the class of wave equations which are Hamiltonian PDEs and null forms, using the flow of an auxiliary Hamiltonian system . This gives a new proof via canonical transformations of the global existence theorems for null form wave equations of S. Klainerman and J. Shatah in space dimensions $n \geq 3$. The case $n = 2$ is also under consideration, which additionally involves a normal forms interpretation of modified scattering. These results are work-in-progress with A. French and C.-R. Yang.