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The Cauchy Problem in Spacetimes with Closed Timelike Curves

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In this talk we will start by reviewing the structure of some model spacetimes containing closed timelike curves (CTCs) such as Misner space, and spacetimes with moving or rotating cosmic strings. In general such spacetimes contain both a choral and non-choral region separated by a Cauchy horizon. We give initial data for the wave equation on a partial Cauchy surface in the choral region and show that the Cauchy problem is well-posed up to and on the chronology horizon. We then consider extending the solution beyond the chronology horizon. In the model spacetimes we can first pass to an covering space and then introduce coordinates so that the identifying isometries are manifest in one periodic coordinate. Factoring out this coordinate we obtain a reduction of the wave equation which turns out to be of mixed type, changing from hyperbolic to elliptic on the horizon. The well-posedness of the solution then turns out to be similar to that of the classical Tricomi problem which is also a PDE which changes type on a hypersurface. We end by discussing the situation in more general spacetimes.

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