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On the smoothness of the critical sets of the cylinder at spatial infinity in vacuum spacetimes

According to Penrose, a spacetime is "asymptotically flat" if it admits a smooth conformal compactification at infinity. This raises the question to what extent Einstein's field equations are compatible with his definition, which has been extensively discussed in the literature with a wide range of opinions. This underlines that the restrictions on the physical data need to be understood which allow for a smooth conformal compactification at infinity in order to give a definite answer whether Penrose's proposal captures sufficiently good models for the physical situations of interest.

A convenient setting to analyze this problem is an appropriately conformally rescaled spacetime where spatial infinity is blown up to a cylinder. It is expected that non-smoothness of null infinity is related to non-smoothness of the critical sets where the cylinder "touches" null infinity. We will consider the appearance of logarithmic terms at these critical sets starting from an "asymptotic initial value problem", where data are prescribed at null infinity.