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Breakdown of von Neumann analysis: a generalized approach for multi-level schemes KOMAL KUMARI, DIEGO A. DONZIS, Texas A&M University — The von Neumann analysis has been extensively used to assess the stability of numerical schemes. It requires bounding the amplification factor(s) by unity to ensure stability. However, through numerical experiments using two well-known multi-level schemes, leapfrog and Du-Fort and Frankel, we note that the amplification computed from these simulations (i) is not equal to that obtained from the von Neumann analysis (ii) exhibits an oscillatory behavior in time and (iii) takes instantaneous values larger than unity despite stability constraints being satisfied. These disagreements are observed because the von Neumann analysis implicitly assumes amplification to be independent of time level. In the generalized von Neumann analysis, we relax this assumption to obtain a time varying amplification factor that agrees exactly with the corresponding numerical value at all times. We re-define stability to account for the variability of amplification with time. Furthermore, we express this new amplification factor as a continued fraction to determine the exact conditions when the standard analysis, if at all, is applicable. Analysis of asynchrony-tolerant schemes and the effect of temporal discretization on spectral accuracy of spatial schemes will also be discussed.

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