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**New time-adaptive technique for stiff gas dynamics and MHD**

Y.A. OMELCHENKO, H. KARIMABADI, SciberQuest, Inc/UCSD, M.L. GOLDSTEIN, A.V. USMANOV, NASA Goddard Space Flight Center — We present a new time-accurate algorithm for explicit integration of multi-scale gas dynamics and MHD equations. Unlike conventional time-stepping schemes, this technique is based on the discrete-event simulation (DES) methodology for stiff PDEs, which allows CPU resource adaptation in accordance with local time scales [1]. DES enables asynchronous (free of the global CFL restriction) flux-conservative integration on arbitrary spatial meshes and eliminates updates in inactive regions of the computation domain. We introduce a new preemptive event processing (PEP) approach, which automatically reduces event-driven integration to synchronous time stepping in regions of configuration space where the change of rate of the solution becomes uniform. This allows efficient parallelization of DES codes. We show that DES can be naturally applied to systems of coupled nonlinear equations. Importantly, we increase the temporal order of accuracy of DES by extending the previous algorithm [1] to second order in time. This is achieved by applying local corrections to the solution obtained with the forward Euler scheme. We demonstrate the accuracy, efficiency and robustness of DES-PEP by comparing numerical solutions obtained in event-driven and equivalent time-stepping simulations of several gas dynamics problems. [1] Y.A. Omelchenko and H. Karimabadi, *J. Comp. Phys.* **216**, 179-194 (2006).

Y.A. Omelchenko
SciberQuest, Inc/UCSD

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