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Quokka: A code for two-moment AMR radiation hydrodynamics on GPUs

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We present Quokka, a new subcycling-in-time, block-structured adaptive mesh refinement (AMR) radiation hydrodynamics code optimised for graphics processing units (GPUs). Quokka solves the equations of hydrodynamics with the piecewise parabolic method (PPM) in a method-of-lines formulation, and handles radiative transfer via the variable Eddington tensor (VET) radiation moment equations with a local closure. In order to maximise GPU performance, we combine explicit-in-time evolution of the radiation moment equations with the reduced speed-of-light approximation. We show results for a wide range of test problems for hydrodynamics, radiation, and coupled radiation hydrodynamics. On uniform grids in 3D, we achieve a peak of 93 million hydrodynamic updates per second per GPU, and 22 million radiation hydrodynamic updates per second per GPU. For radiation hydrodynamics problems on uniform grids in 3D, our code also scales from 4 GPUs to 256 GPUs with an efficiency of 80 percent. The code is publicly released under an open-source license on GitHub.

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