Benchmark-quality time dependent transport solutions using a moving mesh

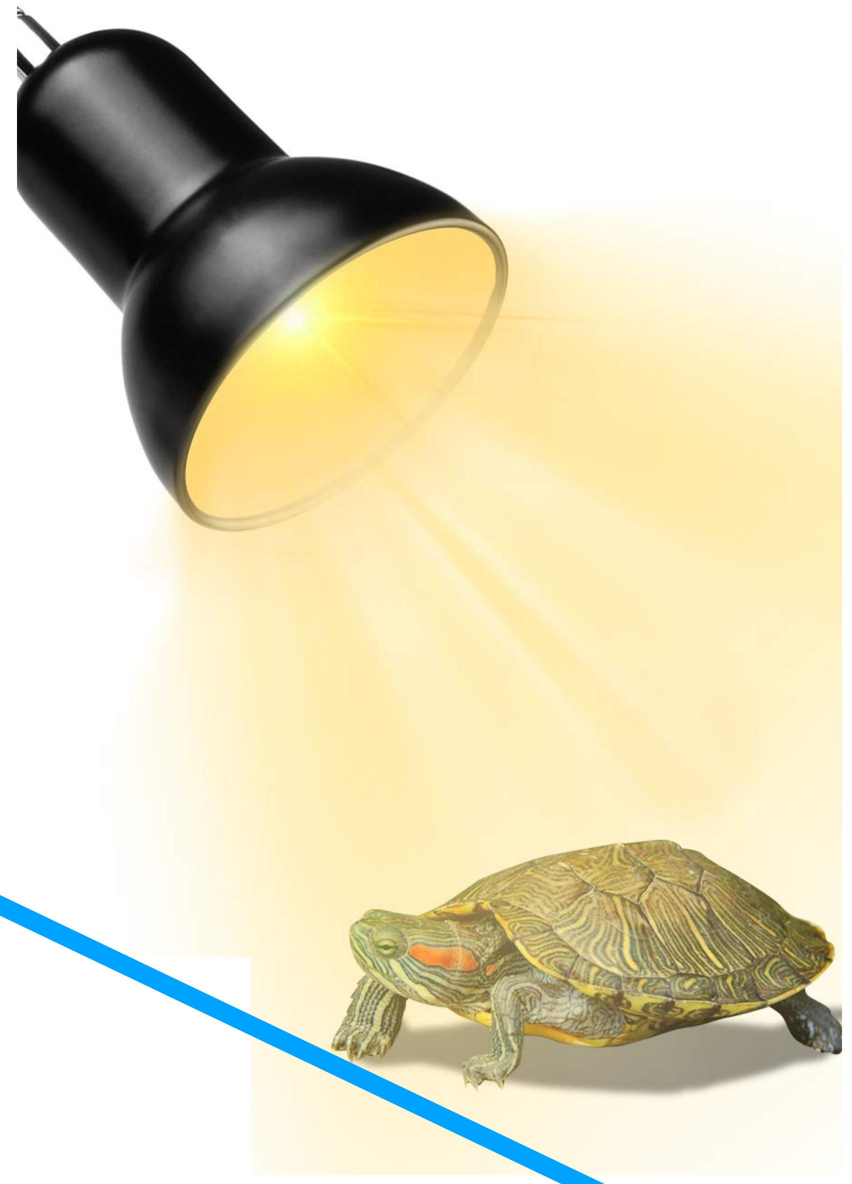
William Bennett
Ryan McClarren
University of Notre Dame

Radiation source

$x = -\infty$ $x = 0$ $x = \infty$

Radiation transport

Radiative transfer

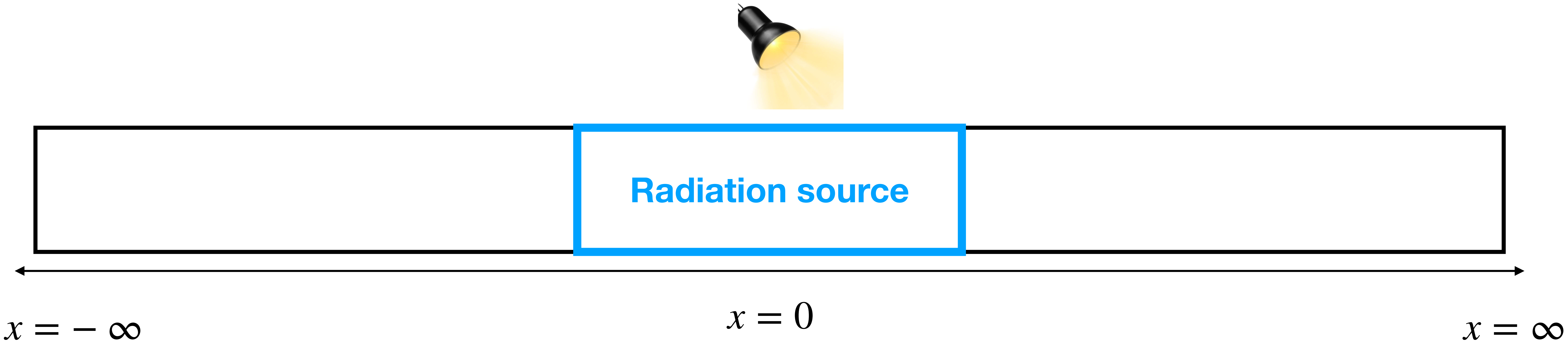


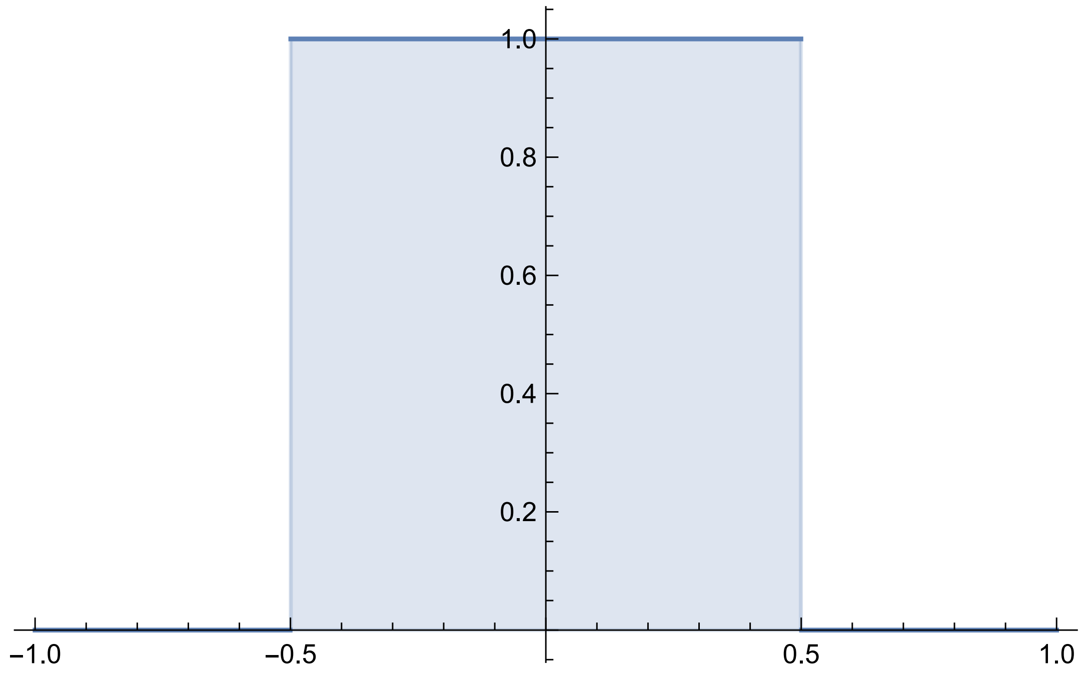
$$\frac{\partial E}{\partial t} = \sigma_a \left(\phi - T^4 \right)$$

and Transport

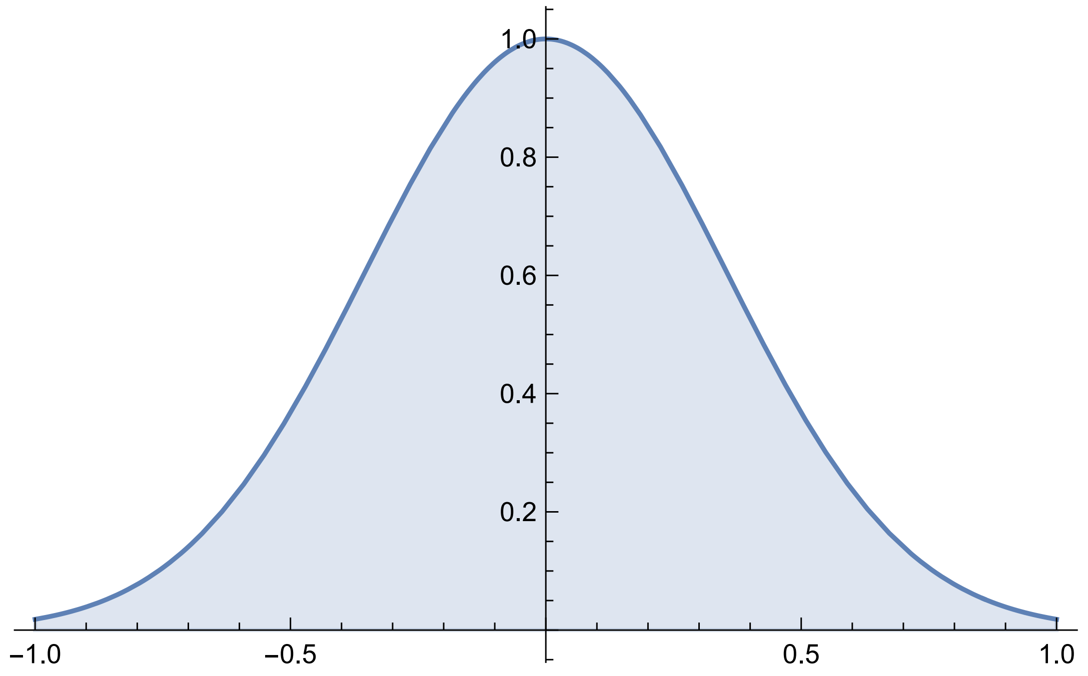
Rad-hydro

Punting on this one — not this PhD





Square source



Gaussian source

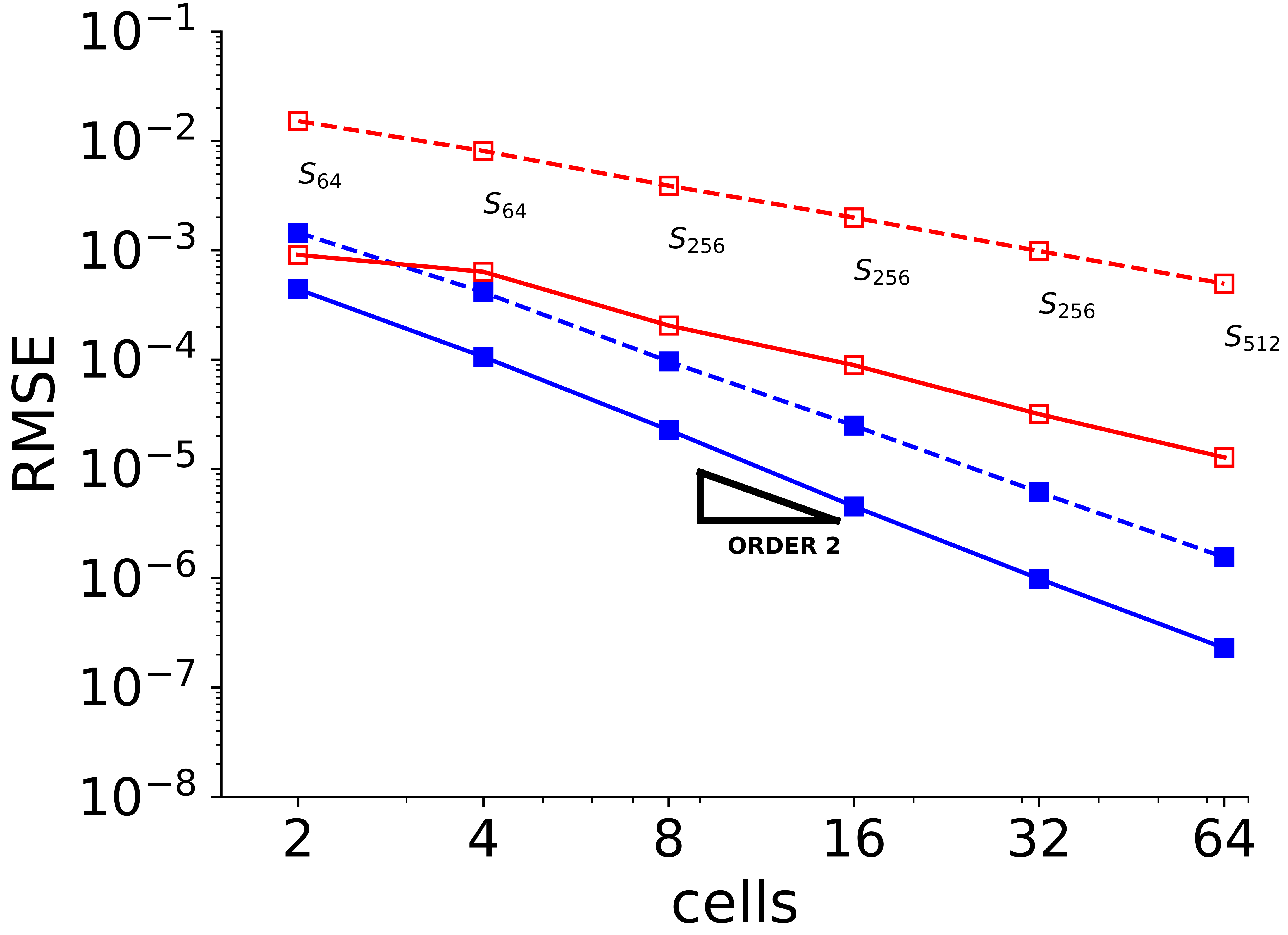
Radiation transport: a few solutions exist

Radiative transfer: one solution exists

Rad-hydro: no solutions

Transport results — Square pulse

$t = 1$



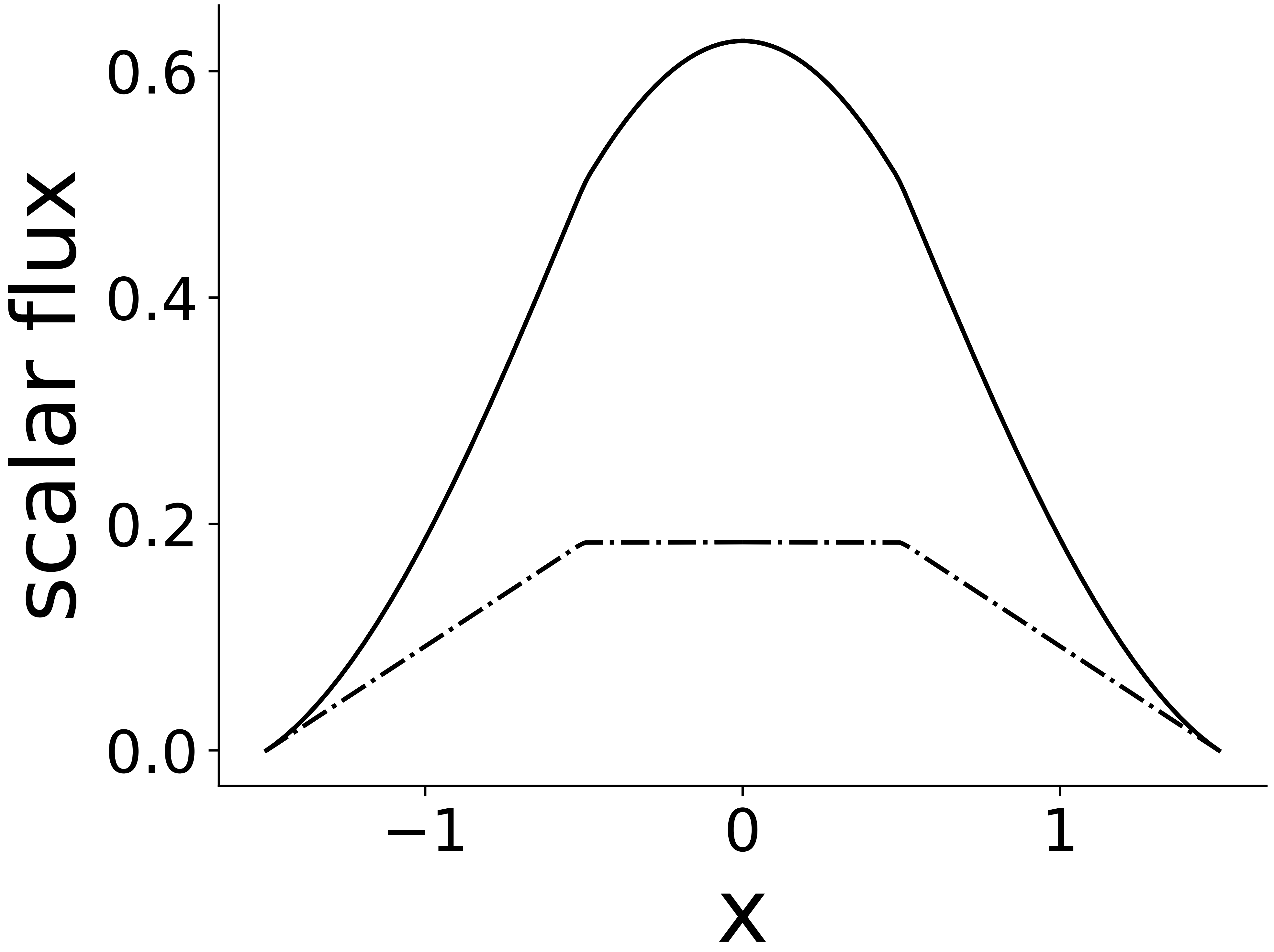


Figure 3: Log-log square pulse convergence results at $t = 1$ increasing number of spatial cells (left) with solution plot(right)

Transport results — Gaussian pulse

$t = 1$

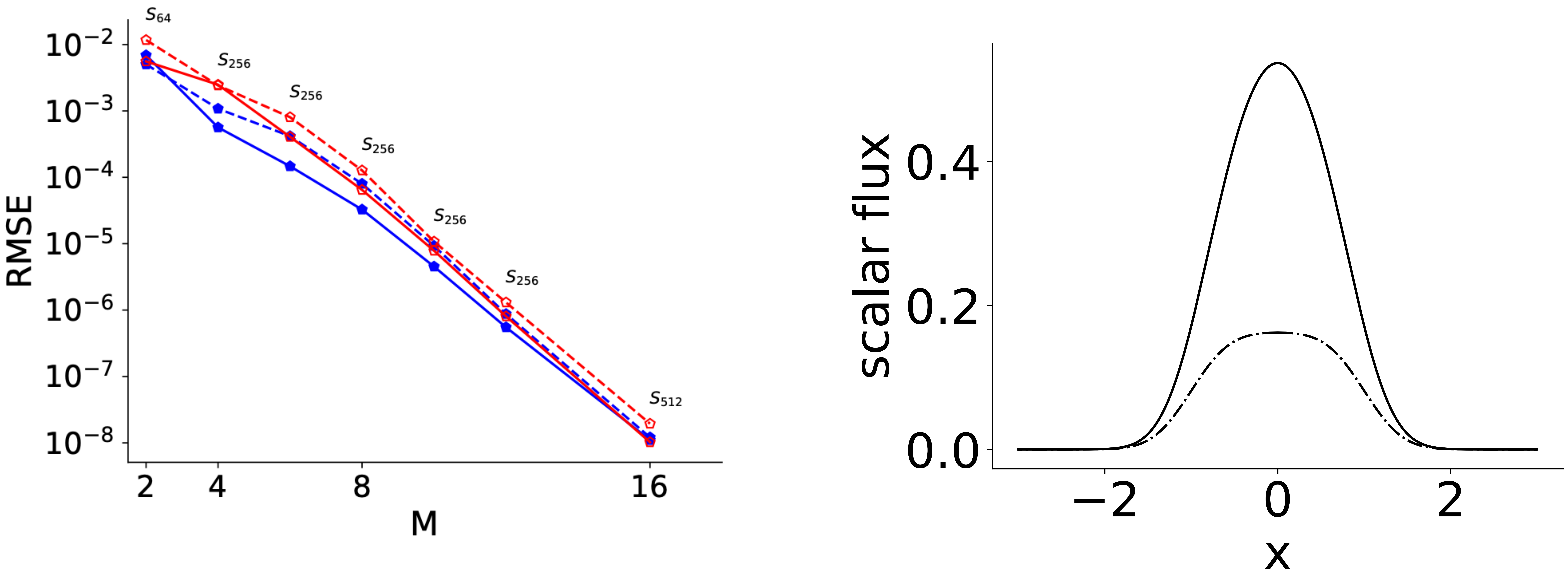


Figure 3: Log-linear Gaussian pulse convergence results at $t = 1$ increasing order of the basis (left) with solution plot(right)

Radiative transfer results — Square pulse

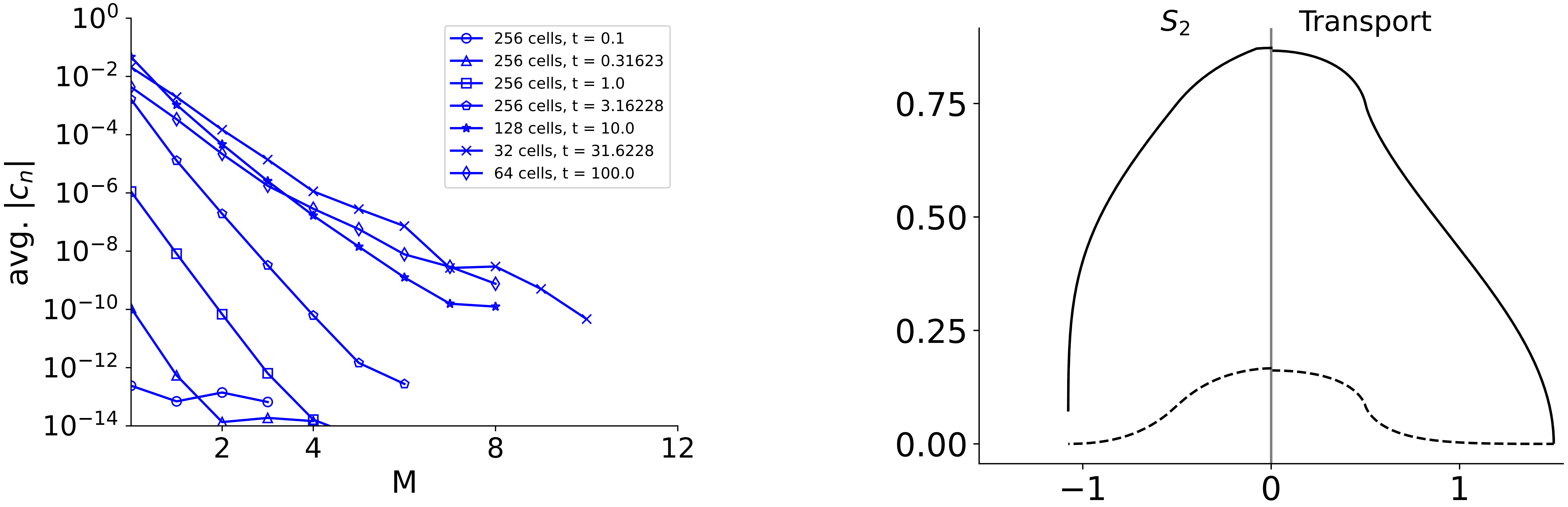


Figure 3: Log-linear square pulse with material coupling convergence results at $t = 1$ increasing order of basis (left) with solution plot(right)

Papers and presentations

[1] Bennett, W., & McClarren, R. G. (2021). Self-similar solutions for high-energy density radiative transfer with separate ion and electron temperatures. *Proceedings of the Royal Society A*, *477*(2249), 20210119.

[2] Bennett, W., & McClarren, R. G. (2022). Benchmarks for infinite medium, time dependent transport problems with isotropic scattering. *Journal of Computational and Theoretical Transport*, *51*(4), 205-221.

[3] Bennett, W., & McClarren, R. G. (2023). Benchmark solutions for radiative transfer with a moving mesh and exact uncollided source treatments. *arXiv preprint arXiv:2301.02596*.

[4] Bennett, W., & McClarren, R. G. (2023). Accurate solutions to time dependent transport problems with a moving mesh and exact uncollided source treatments. *Annals of Nuclear Energy*, *180*, 109474.