Radiative transfer modelling in star-formation studies

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In star-formation studies, one needs to interpret spectral-line measurements of interstellar gas clouds and the emission, scattering, and extinction caused by interstellar dust particles. Radiative-transfer calculations are used to analyse measurements, create synthetic observations based on existing models, and as a part of multi-physics ab-initio numerical modelling. The high resolution of modern observations and simulations sets high requirements also for the efficiency of radiative-transfer calculations.

We have recently developed two new radiative transfer programs. SOC is a Monte-Carlo program for the modelling of dust emission and scattering, with some capabilities also for simulations of polarised dust emission [1]. The LOC program is correspondingly used for spectral-line calculations in 1D and 3D geometries [2]. Both programs can be run either on CPUs (shared-memory computers) or on GPUs.

I will discuss some details of the program implementations, present comparisons of CPU and GPU performance for different types of problems, and show examples of studies where LOC and/or SOC are used to model astronomical observations [3, 4, 5]. I will end by outlining plans for future improvements.

References

[1] M. Juvela, *SOC program for dust continuum radiative transfer*, *Astronomy & Astrophysics*, **622**, A79 (2019).

[2] M. Juvela, *LOC program for line radiative transfer*, *Astronomy & Astrophysics*, **622**, A79 (2020).

[3] M. Juvela, N. Sharma, E. Mannfors, et al., *Dust emission, extinction, and scattering in LDN 1642*, *Astronomy & Astrophysics*, **643**, A132, (2020).

[4] Z.-J. Lu, V.-M. Pelkonen, M. Juvela, et al. *Physical properties and real nature of massive clumps in the galaxy*, *MNRAS* **510**, 1697, (2022).

[5] Z.-J. Lu, V.-M. Pelkonen, M. Juvela, et al. *The dynamical state of massive clumps*, *MNRAS* **509**, 5589, (2022)