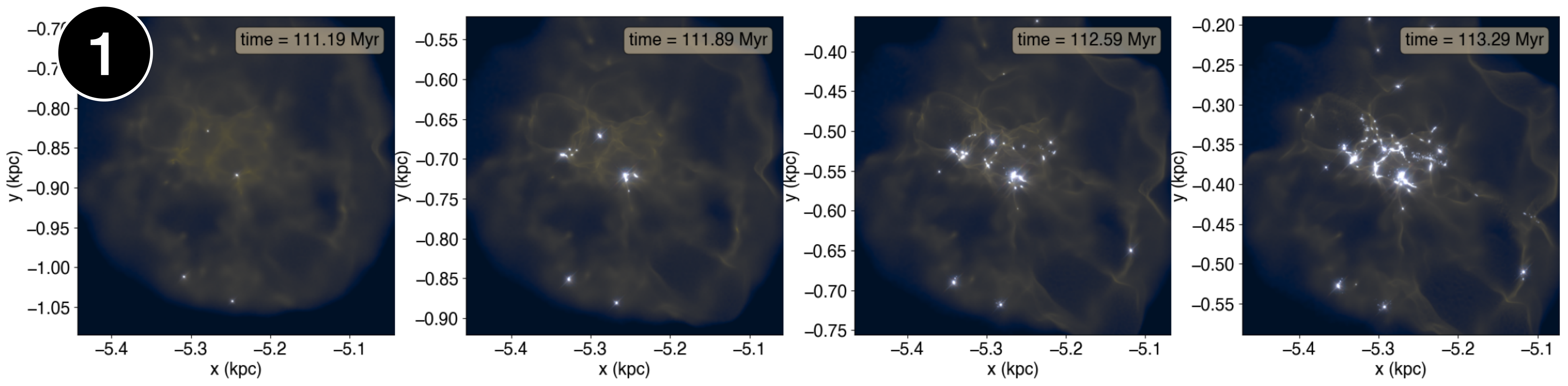
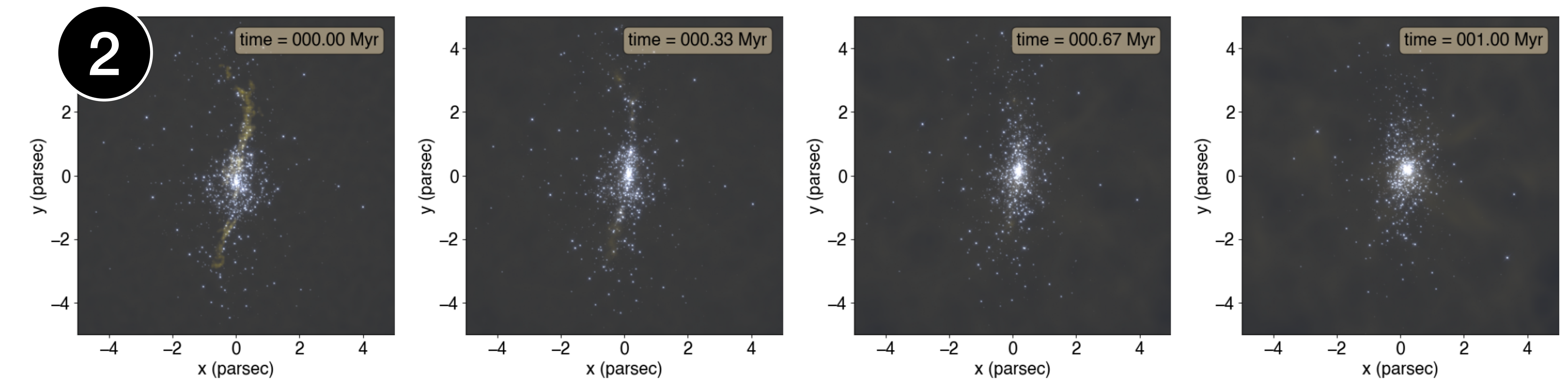
GMC and Orion

We use Ekster to simulate the formation of star clusters from molecular clouds in a spiral galaxy simulation (**Fig. 1**, **(1)**) and in a reconstruction of the Orion nebula (**Fig. 2**, **(2)**).

In the cloud simulations (**(1)**, top), we see that in ~2 Myr, clusters form from multiple cores, accreting matter along filaments before forming more spherical structures.

In the Orion simulation (**(2)**, bottom), we see that the filamentary structure that currently exists will continue to form stars, while contracting to a more spherical cluster within ~1 Myr.





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Forming star clusters with Ekster

https://github.com/rieder/ekster

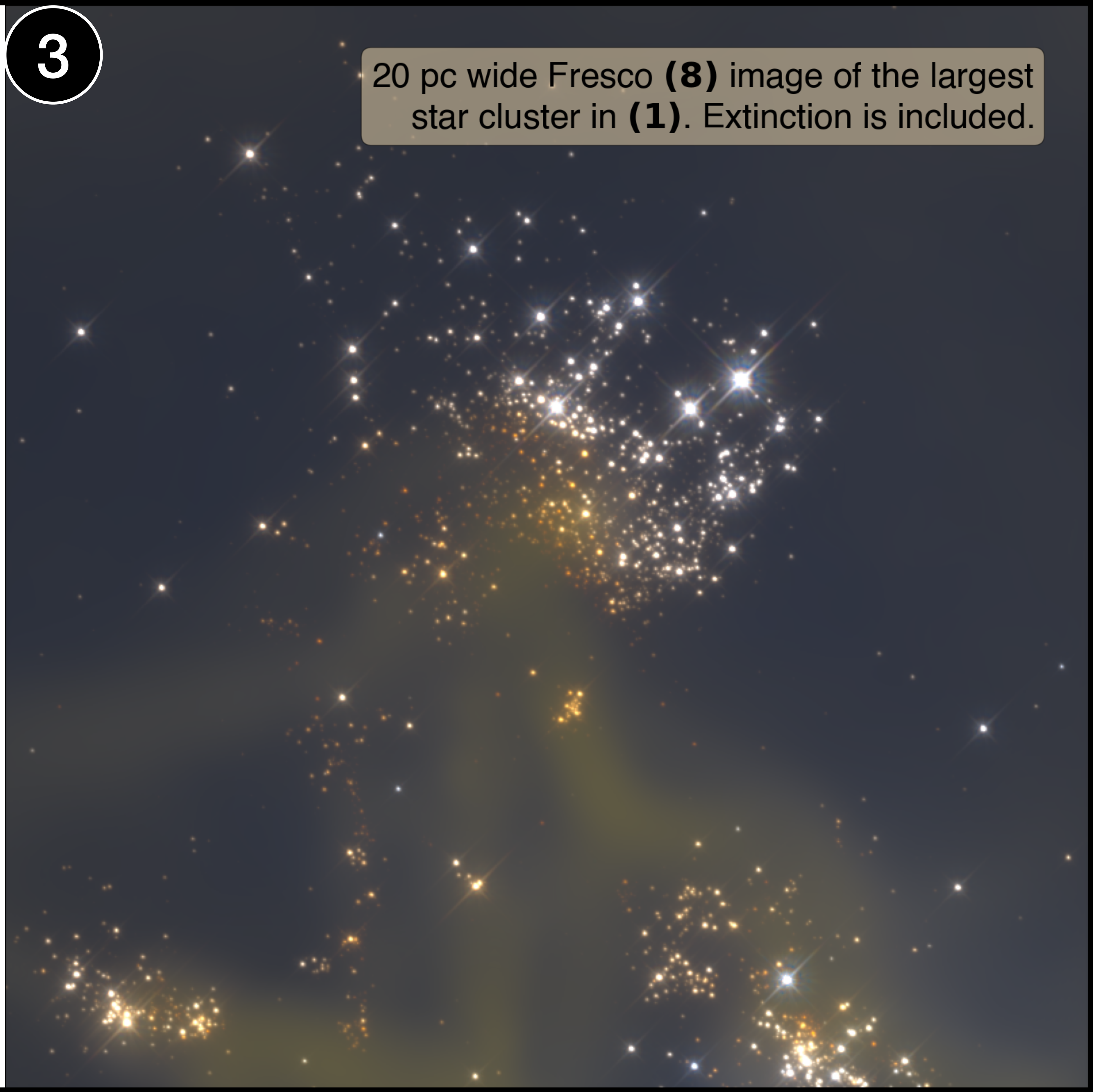
The Ekster method

Ekster **(1)** uses AMUSE **(3)** to combine high-precision N-body dynamics with hydrodynamics. We use Ekster to simulate the formation of embedded star clusters, while only moderately high resolution is needed for the gas particles. This allows us to study more scenarios.

In its current configuration, Ekster combines the Phantom SPH code **(4)** with the PeTar N-body code **(5)** and the SeBa stellar evolution code **(6)**. Additionally, it includes two recipes for star formation, support for feedback modules (e.g. stellar_wind.py, **(7)**) and uses the Fresco visualisation tool (**Fig. 3**, **(8)**) which simulates Hubble images.

To form stars in Ekster, we first create "sink particles", which act as star-forming regions. These accrete gas within an accretion radius, and then create new stars drawing from a Kroupa **(9)** mass function until the region's mass is depleted. Positions are randomly distributed within the accretion radius, and the velocity magnitude is given by the velocity dispersion of the accreted gas. In the optional "grouped" star forming method **(10)**, we allow star-forming regions to be combined, allowing for more massive stars to form.

Future improvements for Ekster include using Arepo **(11)** as the hydro back-end, including radiative feedback (using one of the available modules in AMUSE), and chemical evolution (using MESA **(12)** or GENEC **(13)** for stellar evolution and Krome **(14)** for chemistry).



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AMUSE

AMUSE **(3)** is the Astrophysical Multipurpose Software Environment. It provides a common Python interface to community-developed simulation codes, allowing for rapid prototyping and for simulations that include multiple physical aspects - such as in Ekster.

AMUSE contains community codes covering many physical domains: gravity, hydrodynamics, stellar evolution, radiation and chemistry. As a result, AMUSE can be used in many different scenarios, including star- and planet formation simulations.

All the codes mentioned on this poster are available with an AMUSE interface (GENEC and Arepo interfaces under development).

AMUSE

Bibliography and links

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(12) Paxton et al., 2011, docs.mesastar.org
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