What is the primordial distribution and kinematics of star clusters?

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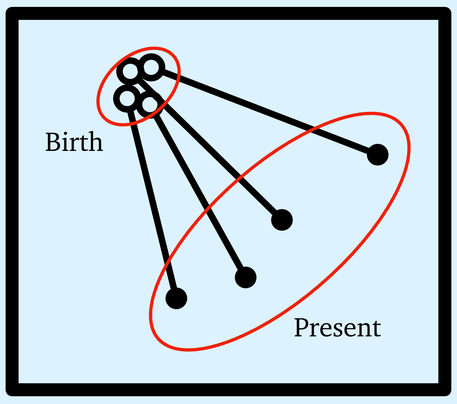
Insights into star formation and dispersal from the synchronization of stellar clocks

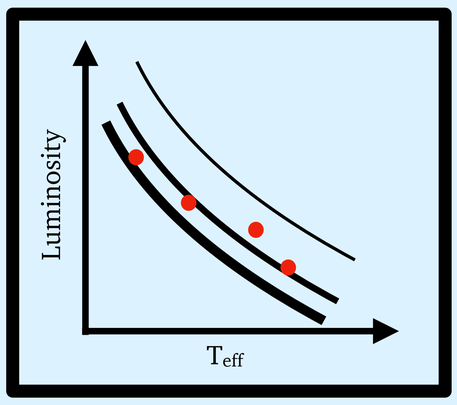
Miret-Roig et al. 2024, Nature Astronomy

Dynamical clock



Traces cluster expansion, since stars are unbound

Isochrone clock



Traces stellar evolution, when protostars become PMS stars

Cluster formation

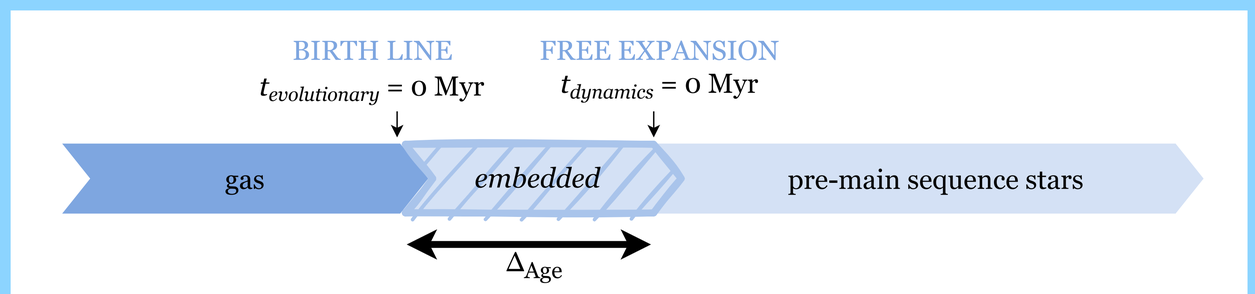
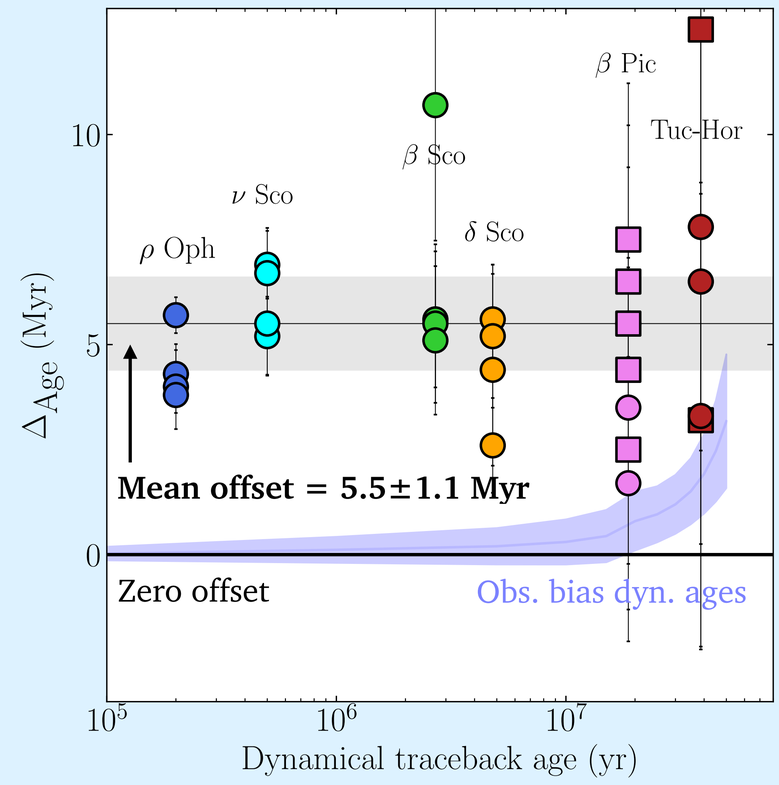


Diagram showing the different phases in the formation of stellar clusters. Ages from evolutionary models are the time from when protostars had accreted most of their final mass and became pre-main sequence (PMS) stars. Dynamical traceback ages are the time since the cluster became unbound and started to expand. The offset between these two techniques (Δ_{Age}) is the timescale of the embedded phase, during which the stars are still bound to the parent gas cloud.

Conclusions

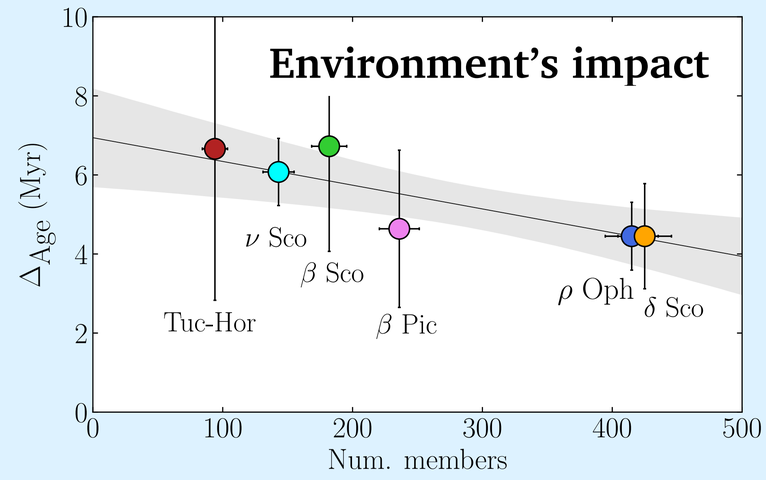
- **Dynamical ages are offer an independent constrain for evolutionary models.**
- **The offset between ages from evolutionary models and dynamical traceback ages carries valuable information on the duration of the gas embedded phase (i.e. the lifetime of molecular clouds after star formation).**

Systematic age offset



Offset between ages from evolutionary models and dynamical traceback ages (Δ_{Age}). Evolution ages include isochrone-fitting (circles) and Lithium depletion boundary (squares).

Environment's impact

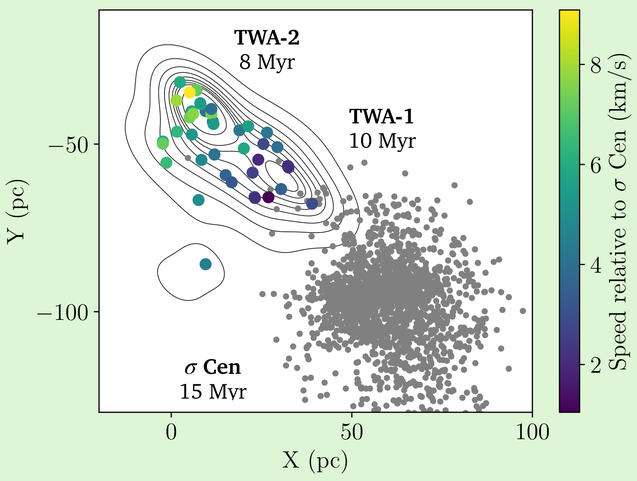


Massive clusters have more stellar feedback (winds and SNe), clear the gas more rapidly and begin expansion earlier.

TWA is a cluster chain of sequential star formation in Sco-Cen

Miret-Roig et al. in prep.

TWA is a chain of two clusters



TW Hydra association (TWA), one of the most well-known young local associations, **is a chain of two clusters**, with the following properties:

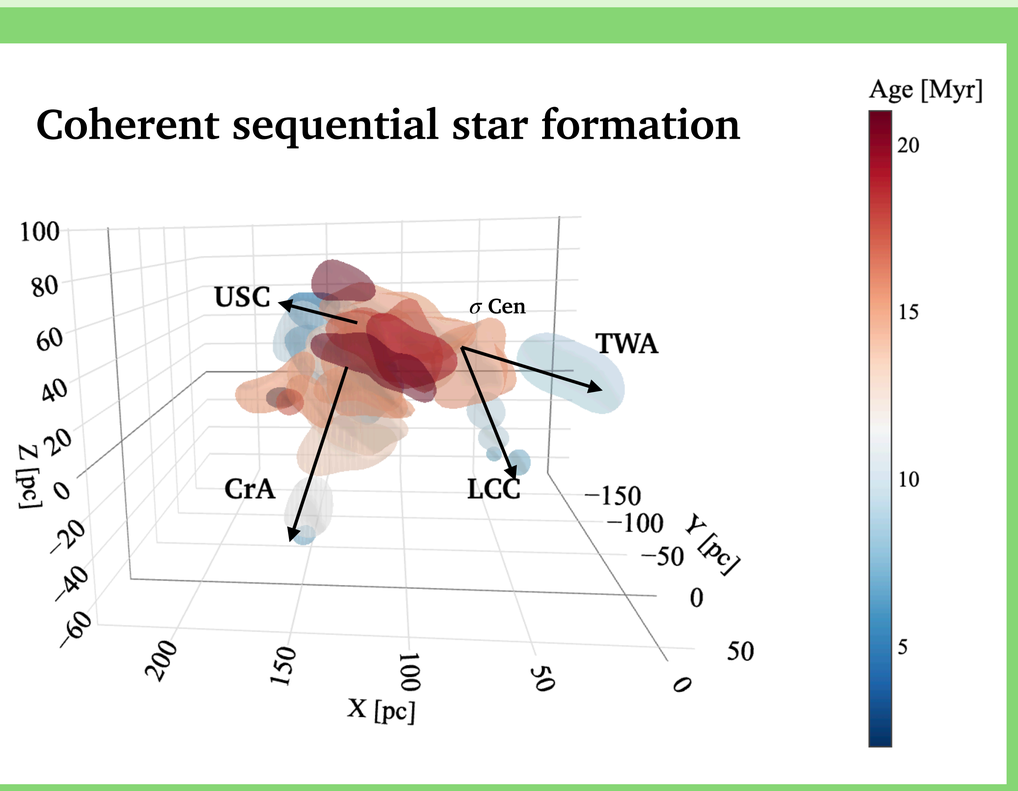
- **Spatial and kinematic coherent structure.**
- **Age gradient**: younger at the outskirts.
- **Acceleration:** further stars moving faster away.
- **Primordial kinematics**: elongation opposite to that produced by Galactic differential rotation.

Obtaining a complete census, an accurate age, and knowing the origin of TWA is crucial for studies of star and planet formation, as several disks, planets and brown dwarfs are known members of TWA.

Conclusions

- **Stars formed in clusters with coherent spatial and kinematic patterns and age gradients. Feedback from massive stars accelerated the motion of clouds at the outskirts and triggered the formation of new generations of clusters.**
- **The primordial distribution and kinematics of clusters is erased within <50 Myr.**
- **Young Local Associations and Moving Groups are the last products of a chain.**

Coherent sequential star formation



3D distribution of the chains of clusters in Sco-Cen and TWA. These chains were discovered by Ratzenböck et al. 2023 and characterized by Posch et al. 2023, 2024.