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Study of Dynamical Evolution of Planetary Orbital Parameters in Star Clusters

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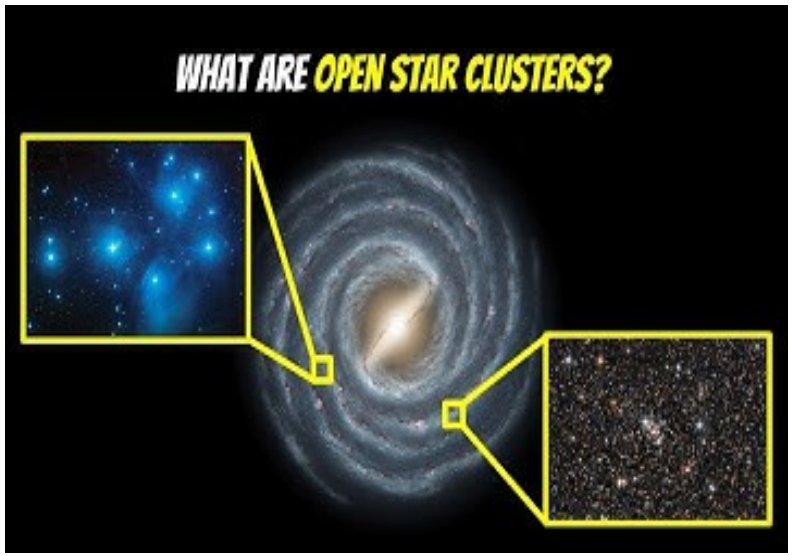
Outline

Introduction to star cluster

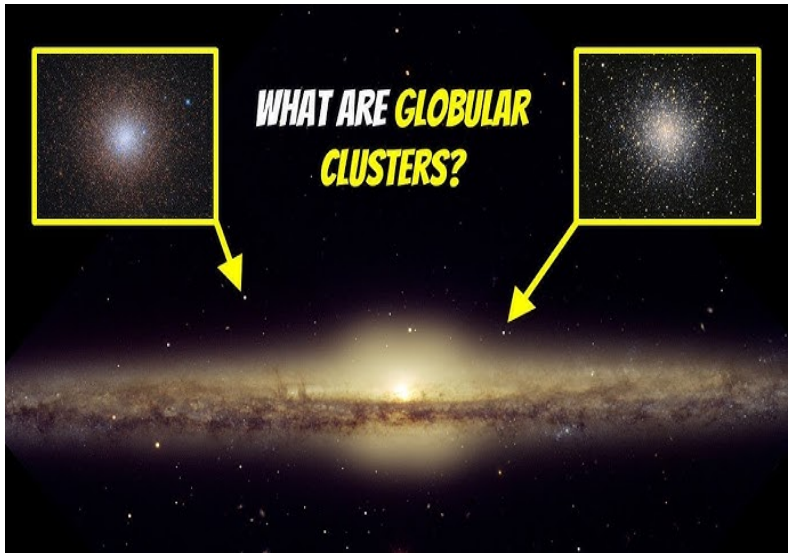
Open star clusters

- $10^2 - 10^4$ members
- High metallicity
- Galactic plane
- Myr-Gyr



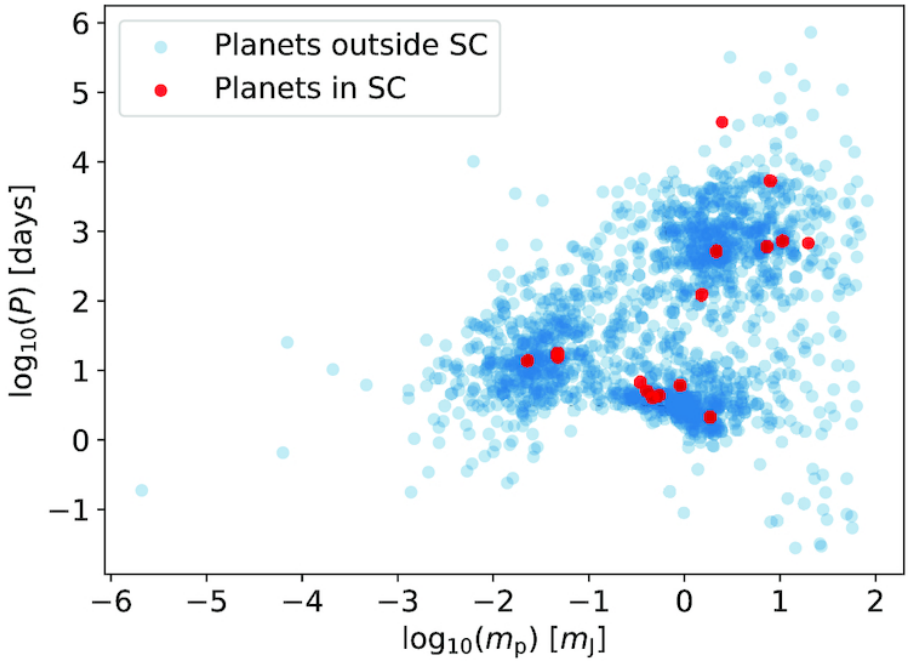
Globular star clusters

- $10^4 - 10^6$ members
- Low metallicity
- Galactic halo
- >1Gyr



Exoplanets in star clusters

- Since 1992, 5741 exoplanets have been discovered, including 31 planets located in star clusters.
- 1 of 31 planets discovered in globular cluster M_4



Maxwell Xu Cai, et al 2019

Our simulation

Initial condition for SC

- N_s=1000
- Half-mass radius: $r_h = 1$ pc.
- Mass of star cluster members: $1M_\odot$.
- Virial ratios: $Q = |T\ /U|$

Initial condition for planet

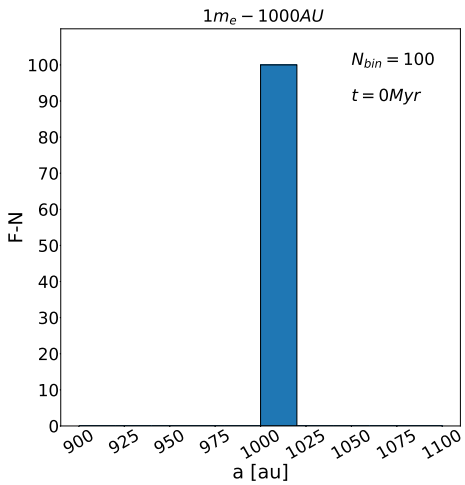
- $a_0 = 1000AU$ and $a_0 = 10AU$.
- Orbital architecture: $(e = 0)$.
- Total planet in SC = 100.
- $M_p = 1m_e$ and $1m_j$.

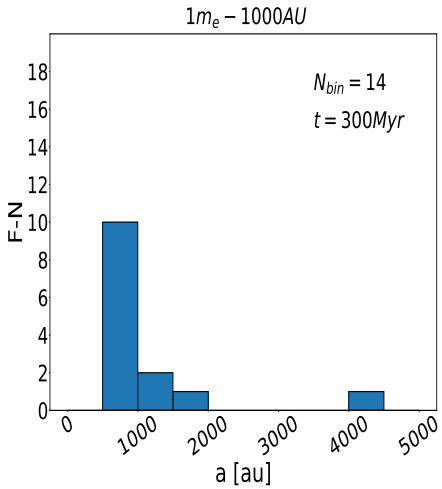
Table: Initial condition of SC and planets.

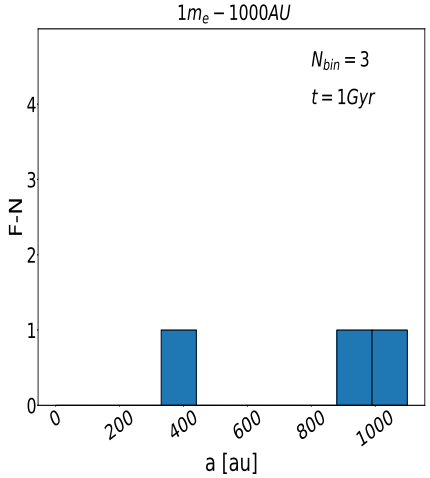
Models	$N_\star$	$r_h[pc]$	$M_\star[M_\odot]$	N_p	m_p	$a[AU]$	e
1	1000	1	1	100	$1m_e$	1000	0
2	1000	1	1	100	$1m_j$	1000	0
3	1000	1	1	100	$1m_e$	10	0
4	1000	1	1	100	$1m_j$	10	0

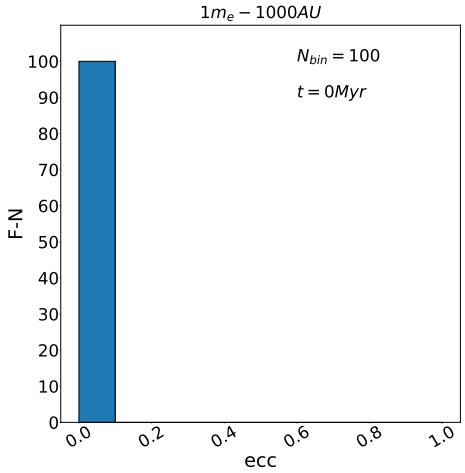
Cumulative evolution of semi-major axis and eccentricity

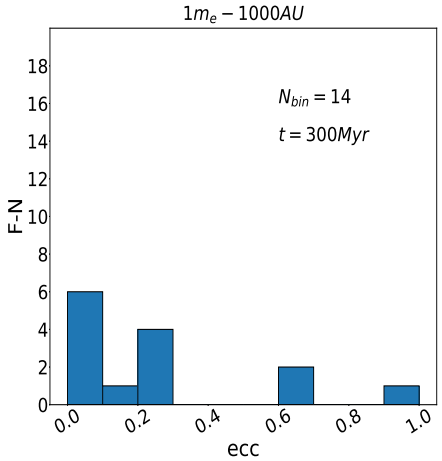
Model-1

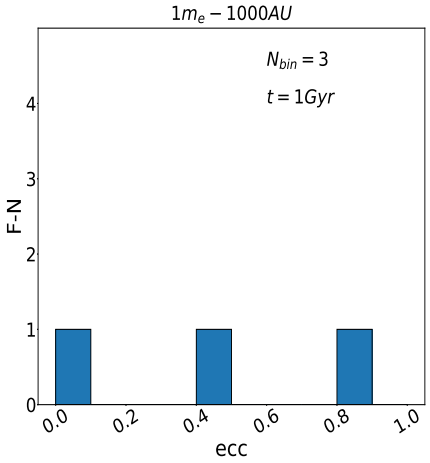






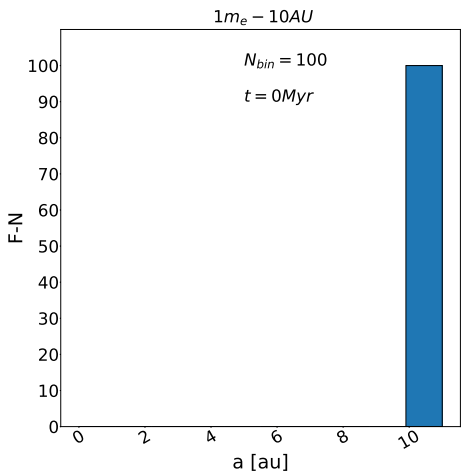


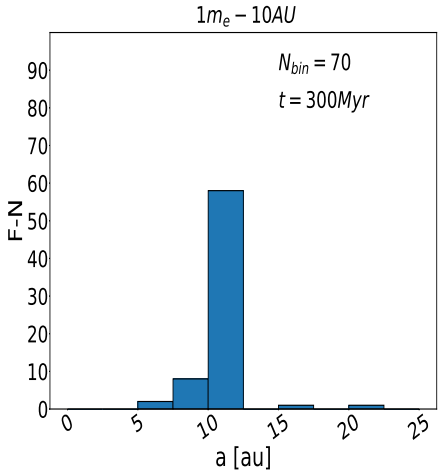


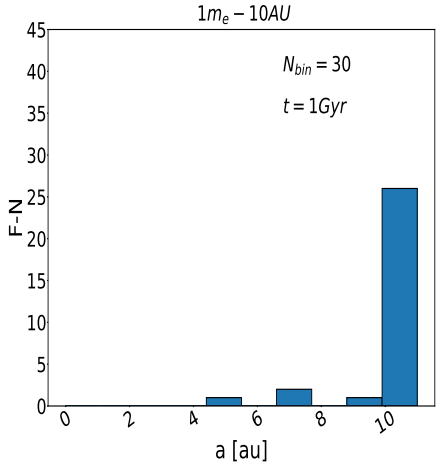


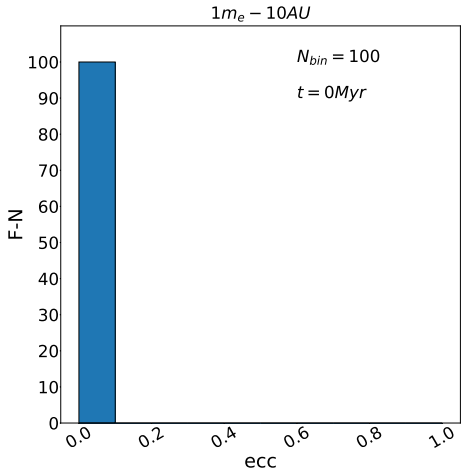
Cumulative evolution of semi-major axis and eccentricity

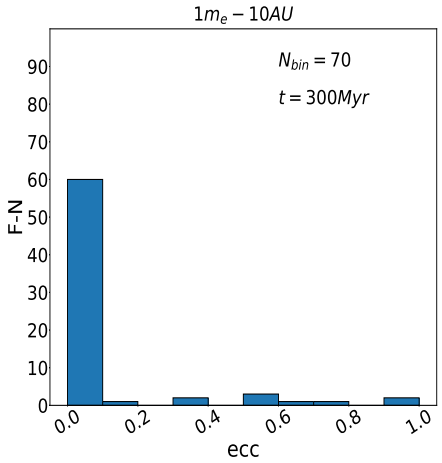
Model-3

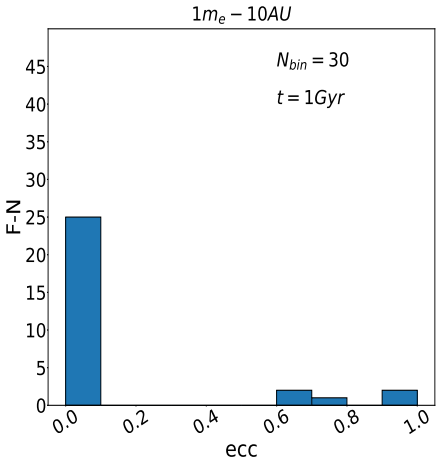






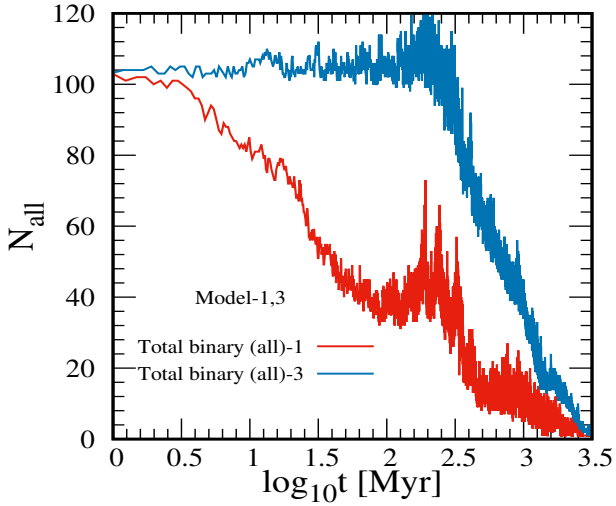


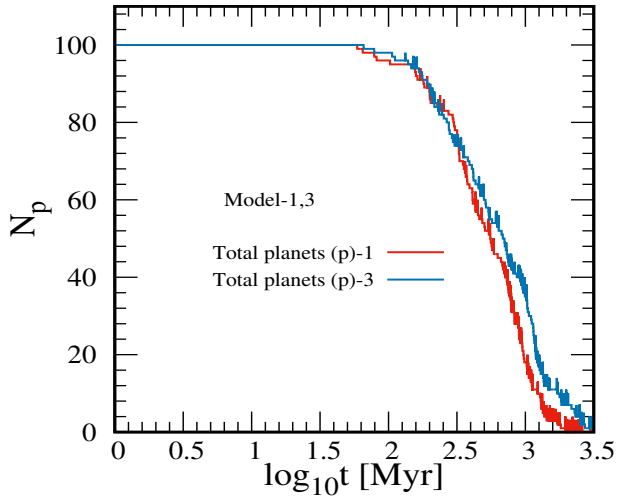


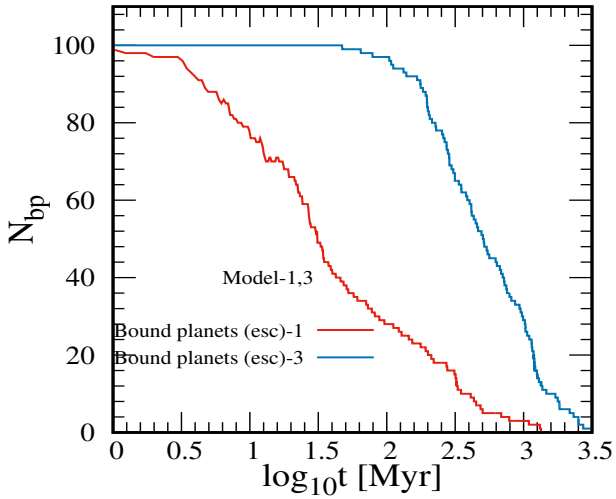


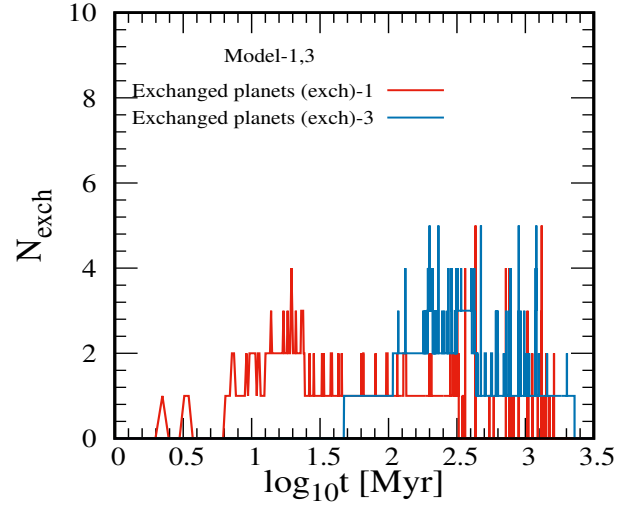
Comparison of model-1 and model-3

Model-3



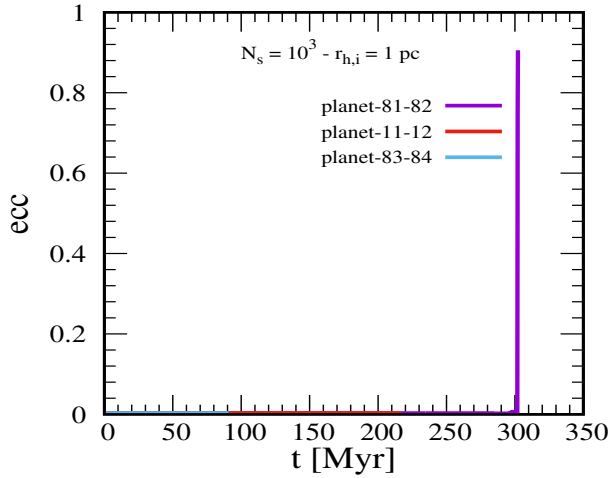


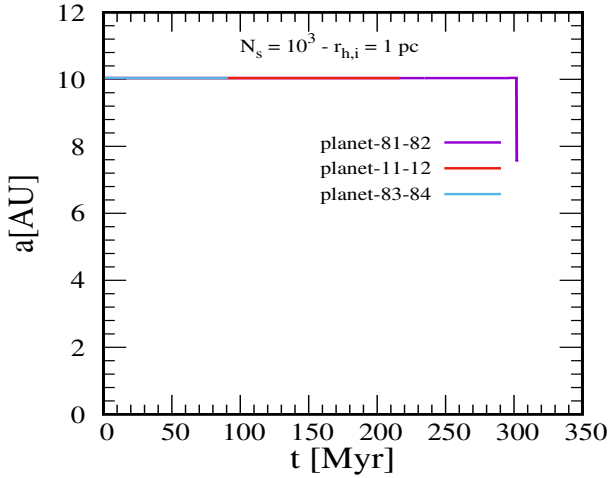


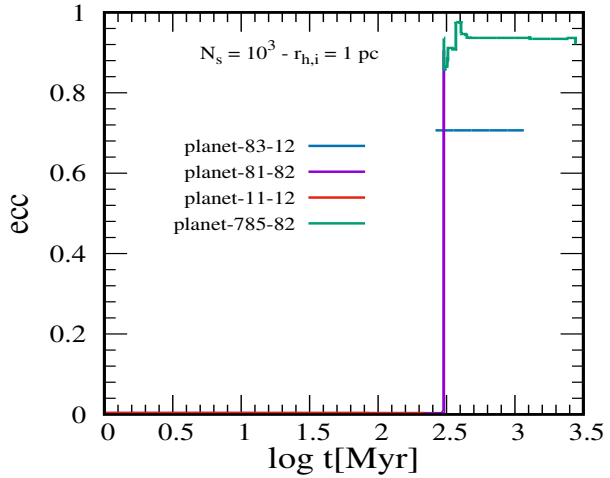


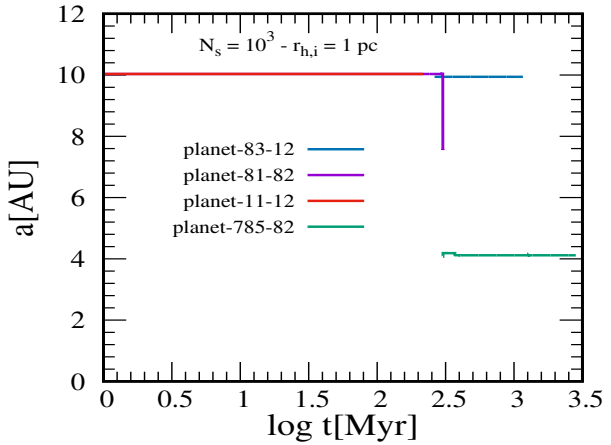
Evolution of planets' orbital parameters

some specific planetary system









Conclusions

- Planetary system in star cluster perturbed by $N-1$ other stars.
- Orbital parameters of planets after encounter, changes.
- Planet captured by flyby stars.
- Compact planetary systems survive more than wide planetary systems, in star clusters.

Future works

- Multiplanetary systems in star clusters.
- Sollar system scenario in star clusters.
- Multi-planetary systems in star clusters in the presence of black holes and remnant.
- Planetary systems in globular clusters.

Acknowledgments

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- I thanks **ICTP** for supporting us and allowing us to present at this conference.

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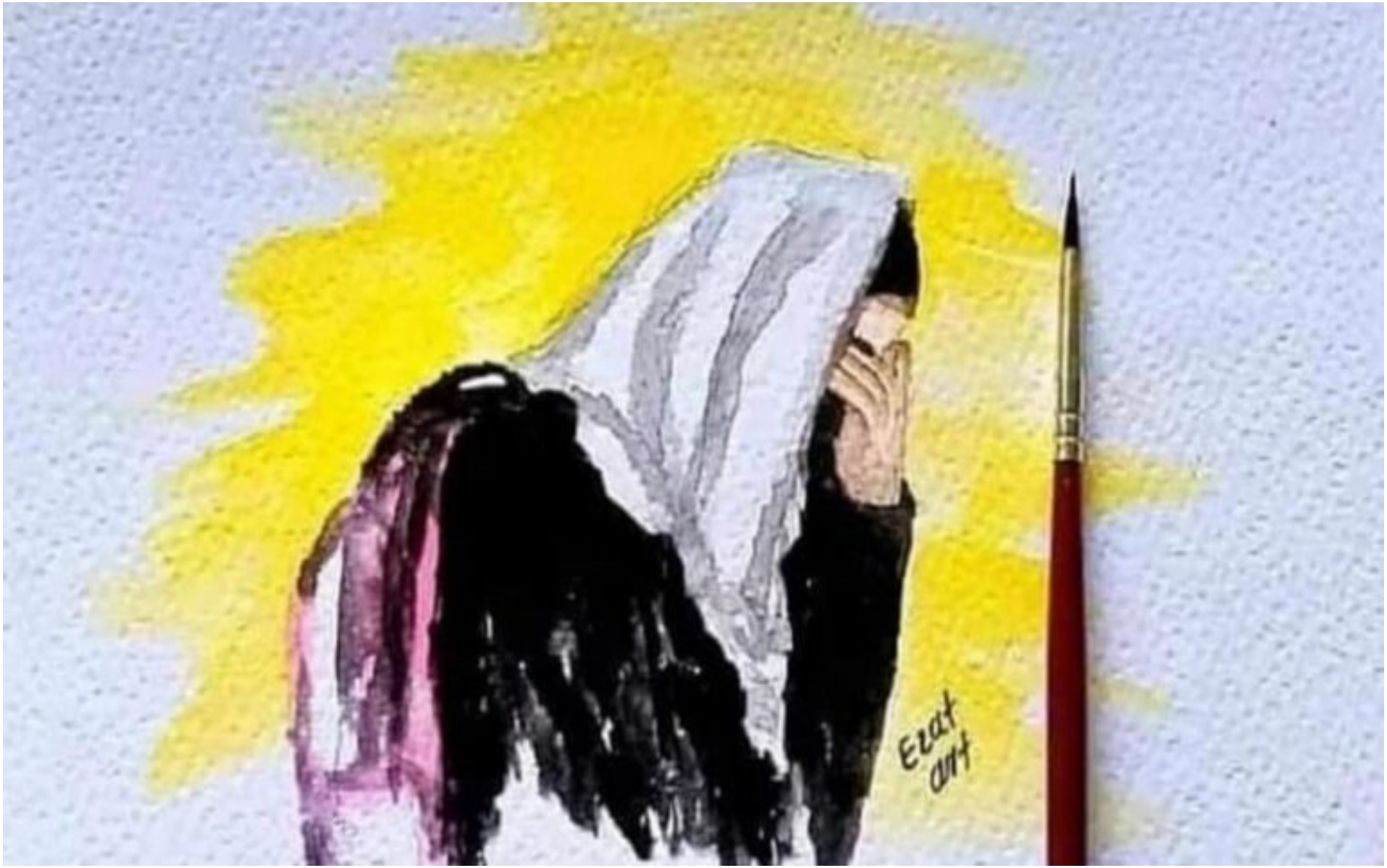

Education is a basic human right.