

Exoplanets Discovered in Clusters – Are They Different?



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ABSTRACT

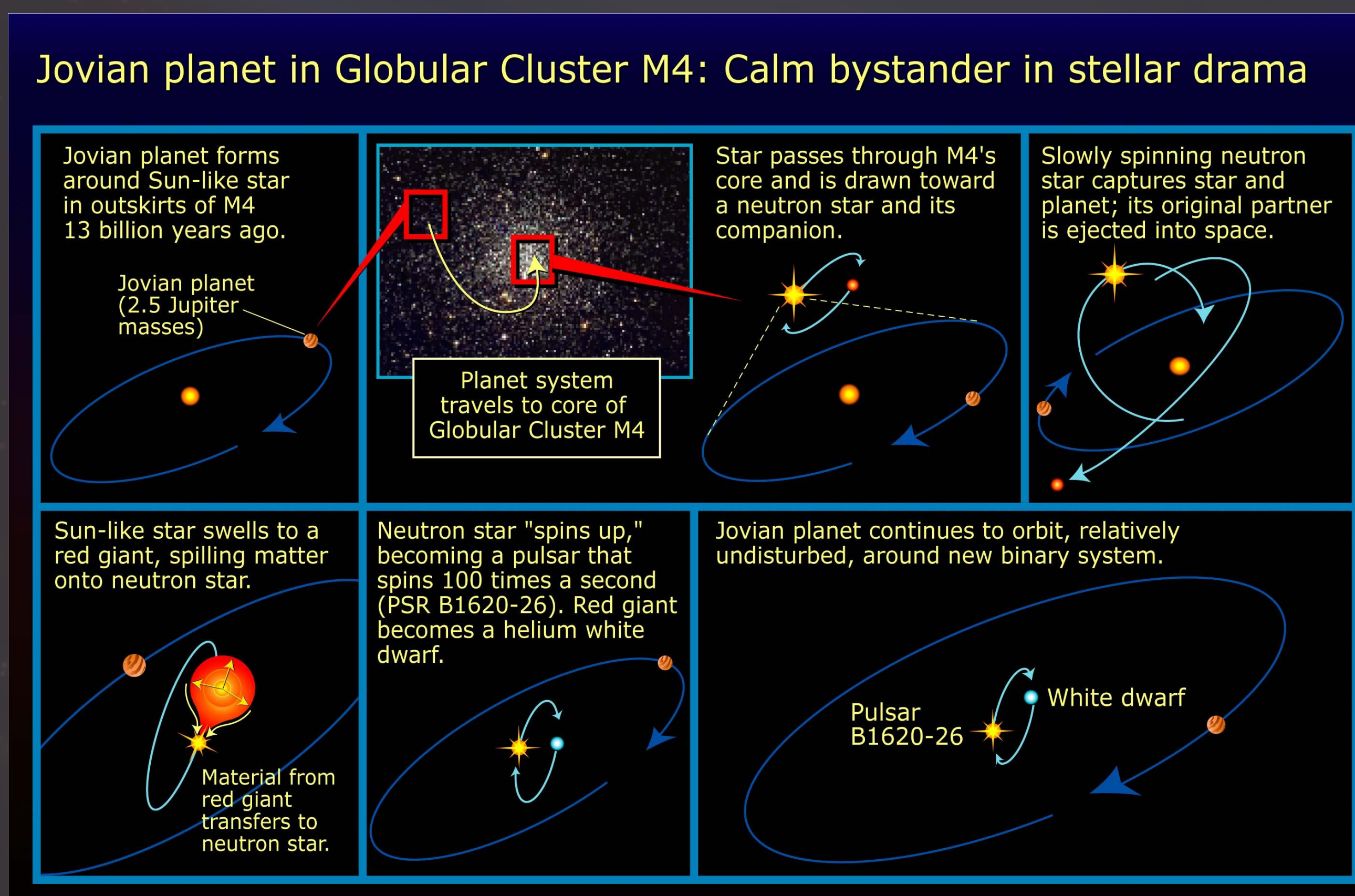
More than three thousand exoplanets have been discovered nowadays. Most of them are orbiting a field star which is located in a suitable environment with a low stellar density inside our galaxy. Clusters, assemblies of stars, create an environment with a much higher stellar density and stars inside are more easily affected by other companion. Planet formation inside clusters, as well as possible migration, will be distinguished from normal exoplanets.

OBSERVATION

Globular Clusters

Only 1 exoplanet (PSR B1620-26 b) has been discovered in globular cluster (Messier 4). It orbits the binary star formed by a pulsar and a white dwarf; this system may be formed by the capture of a neutron star and a single-planet system.

Figure 1 | The evolution of the PSR B1620-26 system. From Wikipeda

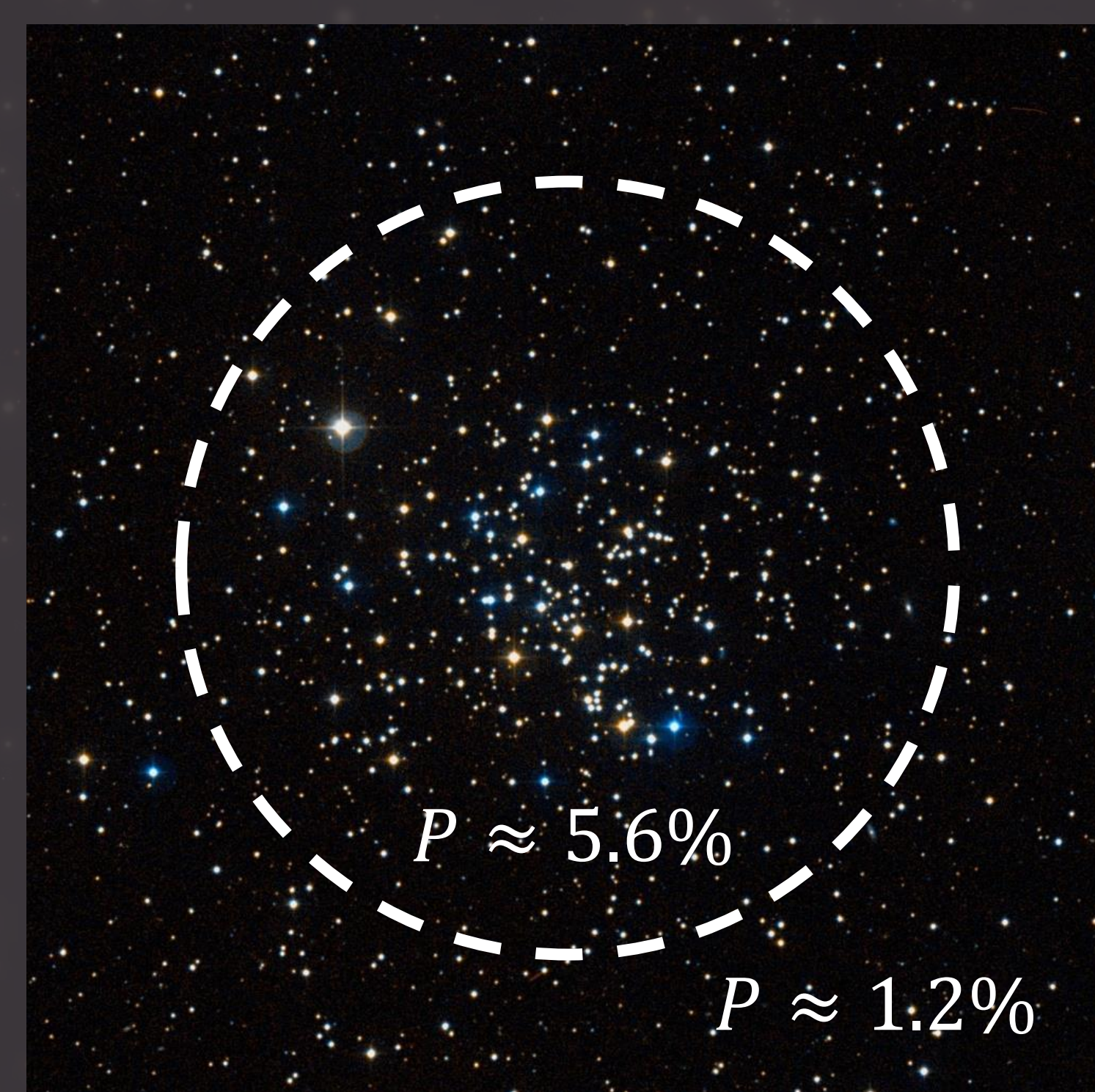


Open Cluster

At least 13 exoplanets have beendiscovered. They include 2 long-period massive planets, 6 hot Jupiters, 2 Neptune like planets, 2 hot Neptunes and a long period giant planet.

Higher discovery rate of hot Jupiter is found inside open clusters. Brucalassi et al derived a rate of 5.6% from observing the radial velocity of 53 single stars in open cluster M67, which is four times higher than the rate of 1.2% for field stars. Though there are many possible reasons, such as stellar metallicity and mass, which may increase the rate, Brucalassi et al stated that the environment is the most important effective element.

Figure 2 | Hot Jupiter discover rate inside and outside M 67



MODELS

Models of exoplanets inside clusters, which contain a large amount of stars, cannot be easily finished until recently, following the improvement of software and hardware. Three types of modelling and a summary of the results are listed here:

Single Planet Systems

Single planet systems provide the upper stability limit. However, they are more easily disrupted by the encounters.

Free Floating Planets (FFP)

Four kinds of FFP movement are predicted by the models.

1. FFPs with high velocity will escape from the cluster immediately;
2. Few others will re-captured by other stars;
3. The majority of low velocity FFPs will likely migrate to outside part of the cluster;
4. Finally, they will escape through ejection or evaporation.

Multi-Planet Systems

The modeling of multi-planet system is much harder than the previous two. Hao et al state that both star encounter and a close-in planet will affect planet movement, and cause orbit variation or planet collision.

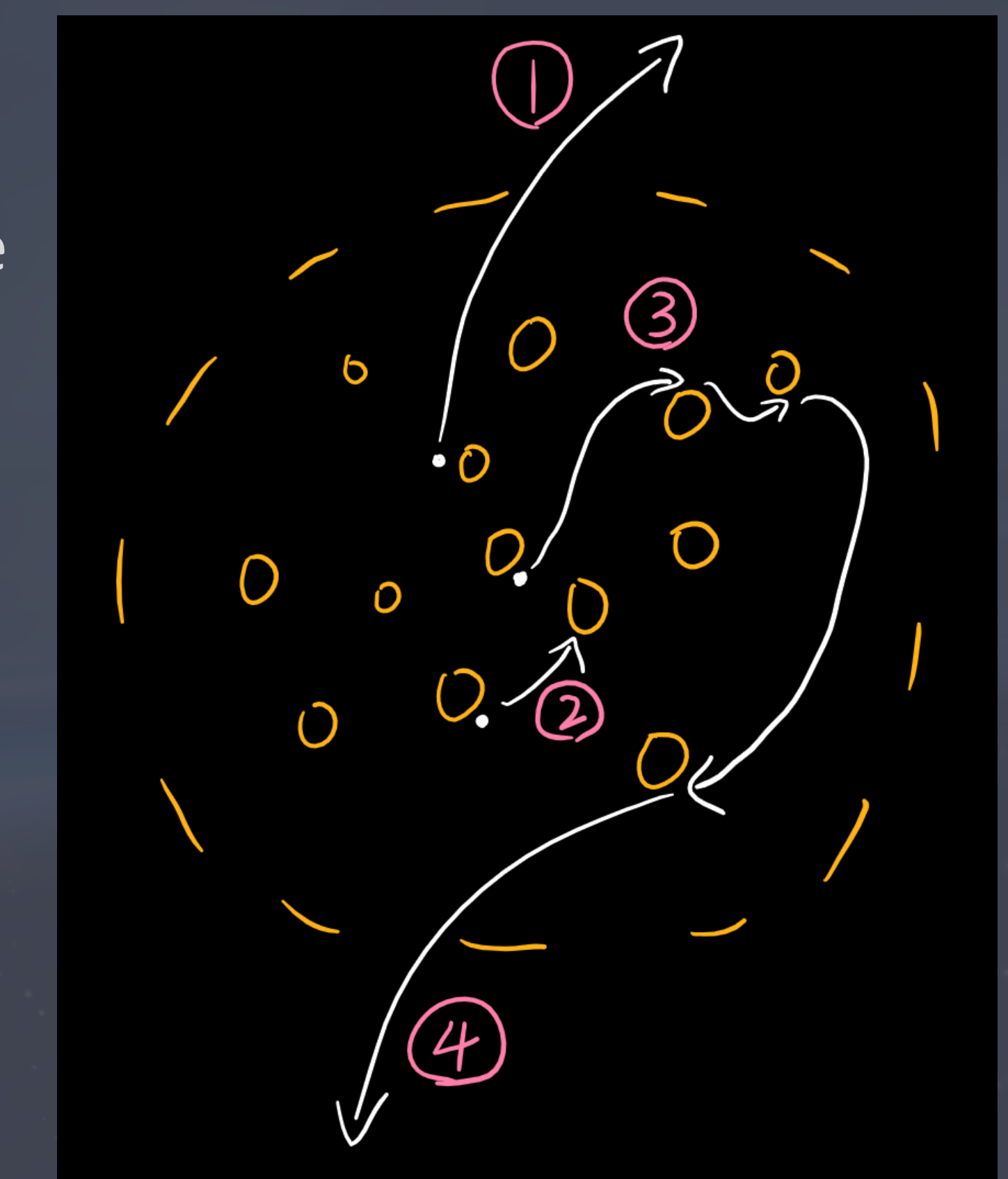


Figure 3 | Four movements of stars inside cluster by modelling.

CONCLUSIONS

- The hot Jupiter discovery rate inside open clusters is higher.
- Planets inside cluster will encounter more serious effects from other stars.
- Based on the number discovered, it is hard to say whether planets inside clusters have different physical properties then those outside clusters.

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