Literature Values Search

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1 Escape Velocity from Dust Disk

This seems very difficult to find as a single equation. Making a very large assumption that the mass is evenly distributed and spherically distributed, we could just say that V_{esc} in the disk is given by Equation 1.

$$V_{esc} = \sqrt{\frac{2G(M_{star} + M_{disk})}{r_{star} + r_{disk}}} \tag{1}$$

2 Lifetime of Biological Material on Rocks in Space

Ginsburg et al. (2018) gives a link for the survival fraction of biological life to its lifetime:

$$f_{surv,bio}(t) = e^{-\frac{t}{\tau_{bio}}} \tag{2}$$

In Equation 2, τ_{bio} is the biological lifetime, and t is some timescale. Ginsburg et al. (2018) estimates $\tau_{bio} = 10^5$yr for a polyextremophile, D. radiodurans.

Valtonen et al. (2008) gives a link between survival time and the radius of the body the biological material is in. This is seen in Equation 3.

$$t^2(Myr) \approx 75l^2 \tag{3}$$

Mileikowsky et al. (2000) gives a survival fraction that depends on many unknowns.

Adams & Napier (2022) looks promising. It gives a distribution of rocky objects by mass:

$$\frac{dN}{dm} = Am^{-p} \tag{4}$$

In Equation 4, m is the mass, N is the number of rocks, and p has values between 1 and 2. When the size-mass distribution is 'determined by collisional processes', $p \approx 1.8$. This can be linked to rock radius if we have an assumed density for these rocks. A is defined in Adams & Napier (2022).

`https://astrostatistics.psu.edu/datasets/asteroid_dens.html#:~:text=However%2C%20the%20internal%20structure%20of,structures%20will%20have%20lower%20density.` gives a density of asteroids ('Oumuamua is said to have the same density – see the Wikipedia page) of 3–5 gcm^{-3}.

Adams & Napier (2022) gives a minimum mass for the rocks to harbour biological life as 10 kg.

Adams & Napier (2022) also gives a minimum rock size for the rocks to harbour biological life as a few centimetres.

Linking density and the mass distribution, we can get the radius of these rocks and thus the survival time of the biological material.

Summary:

- Use Equation 3 to get a survival time for the biological material inside the rock. We still need a radius of the rock

- Use Equation 4 to get a distribution of rock masses and thus radius from typical values for asteroid densities.

2.1 Lifetime of These Rocks

If we have this, then we have t.

'Oumuamua is estimated to be in the age range of 0.20–0.45Gyr (Almeida-Fernandes & Rocha-Pinto 2018). Hsieh et al. (2021), however, gives 30Myr.

It would be better to have a time that depends on the star the rock has been ejected from.

References

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