

Ultra-faint dwarf galaxies as first life-nurseries in the Local Group

We investigate if Local Group dwarf spheroidal (dSph) galaxies might have formed the first planetary systems able to support life. By exploiting the observed chemical abundances and star formation histories, we developed a novel semi-empirical model which quantifies the probability of dSphs to host life-friendly planets by investigating if their stars: (i) reach the minimum heavy elements abundance to trigger planet formation; (ii) dwell in a safe environment to develop life in its embryonic or intelligent form. Although the fraction of stars with overcritical iron-abundance for planet formation, $[\text{Fe}/\text{H}]_{\text{cr}}$, increases with luminosity, we find that bright dSphs are more exposed to sterilization from Supernovae (SNe) and Gamma-ray Bursts, while ultra-faint dSphs (UFDs, $L < 10^5 L_{\odot}$) have the highest probability to survive these destructive events ($P_{\text{surv}} \geq 0.8$). Our results show that UFDs are the first and most life-suitable Local Group galaxies if planet formation is possible below $[\text{Fe}/\text{H}] \sim -1$. Assuming $[\text{Fe}/\text{H}]_{\text{cr}} = -2.5$ we show that $> 50\%$ of stars in UFDs might have hosted life since 13 Gyr ago and sustained it for > 4 Gyrs. By evaluating the abundance of refractory elements relevant for planet formation (Mg, Si and Fe) we find that 50% (1%) of stars in UFDs (dSphs) with $[\text{Fe}/\text{H}] < -2.5$ have a refractory index $[\text{Ref}/\text{H}] > -2.5$, being Mg-, Si- (and C-) enhanced by primordial SNe. Thus, our findings suggest that UFDs might represent the first life-nurseries of our Local Group, reaching the two key conditions for hosting life during the first billion years of cosmic evolution.

Primary author: CIABATTINI, Stefano (Università degli Studi di Firenze)

Co-authors: Prof. SALVADORI, Stefania (Università degli Studi di Firenze); TESTI, Leonardo (Dipartimento di Fisica e Astronomia, Università di Bologna)

Presenter: CIABATTINI, Stefano (Università degli Studi di Firenze)

Session Classification: Session 5