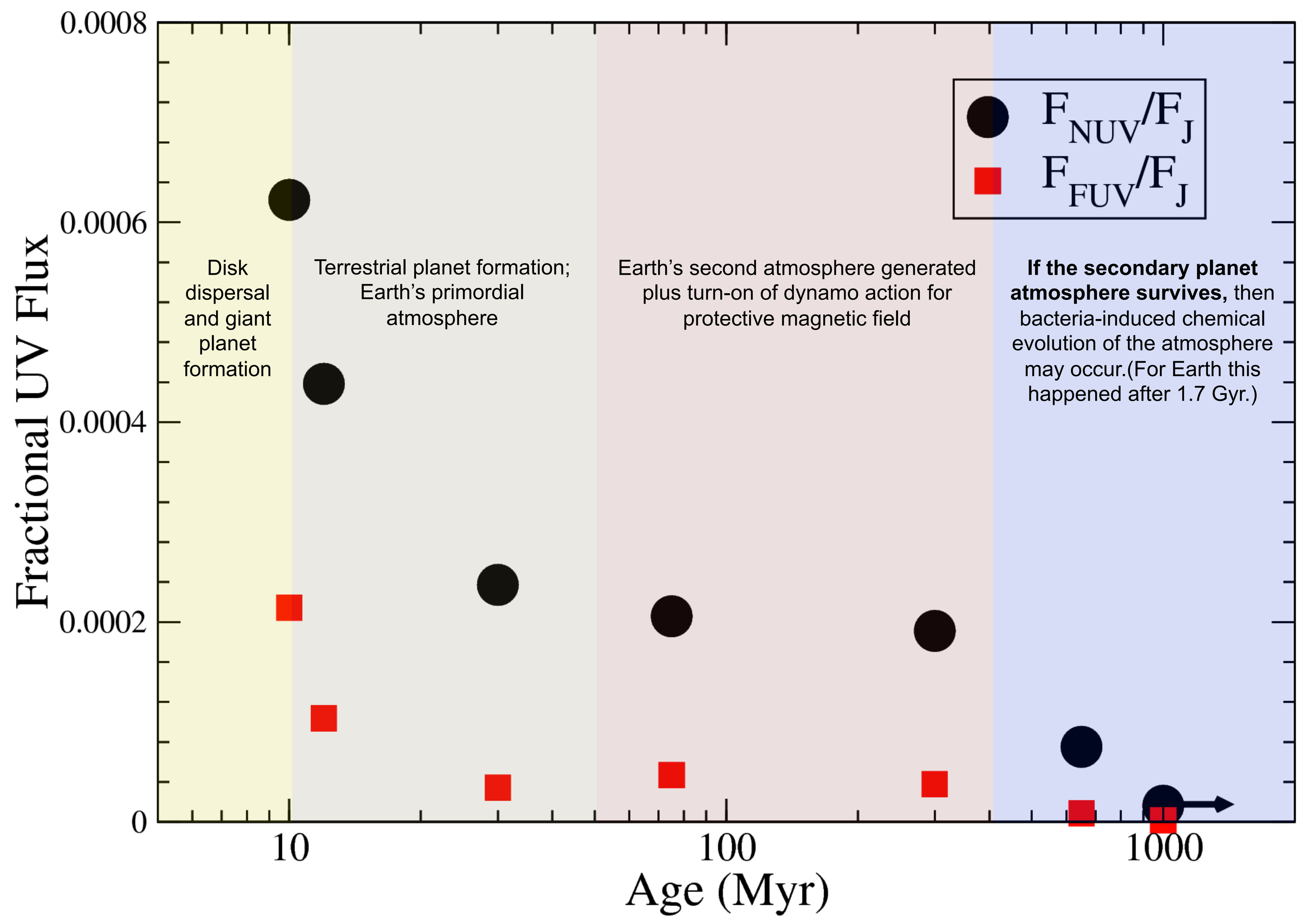
HAZMAT:
HABITABLE ZONES AND M DWARF ACTIVITY ACROSS TIME

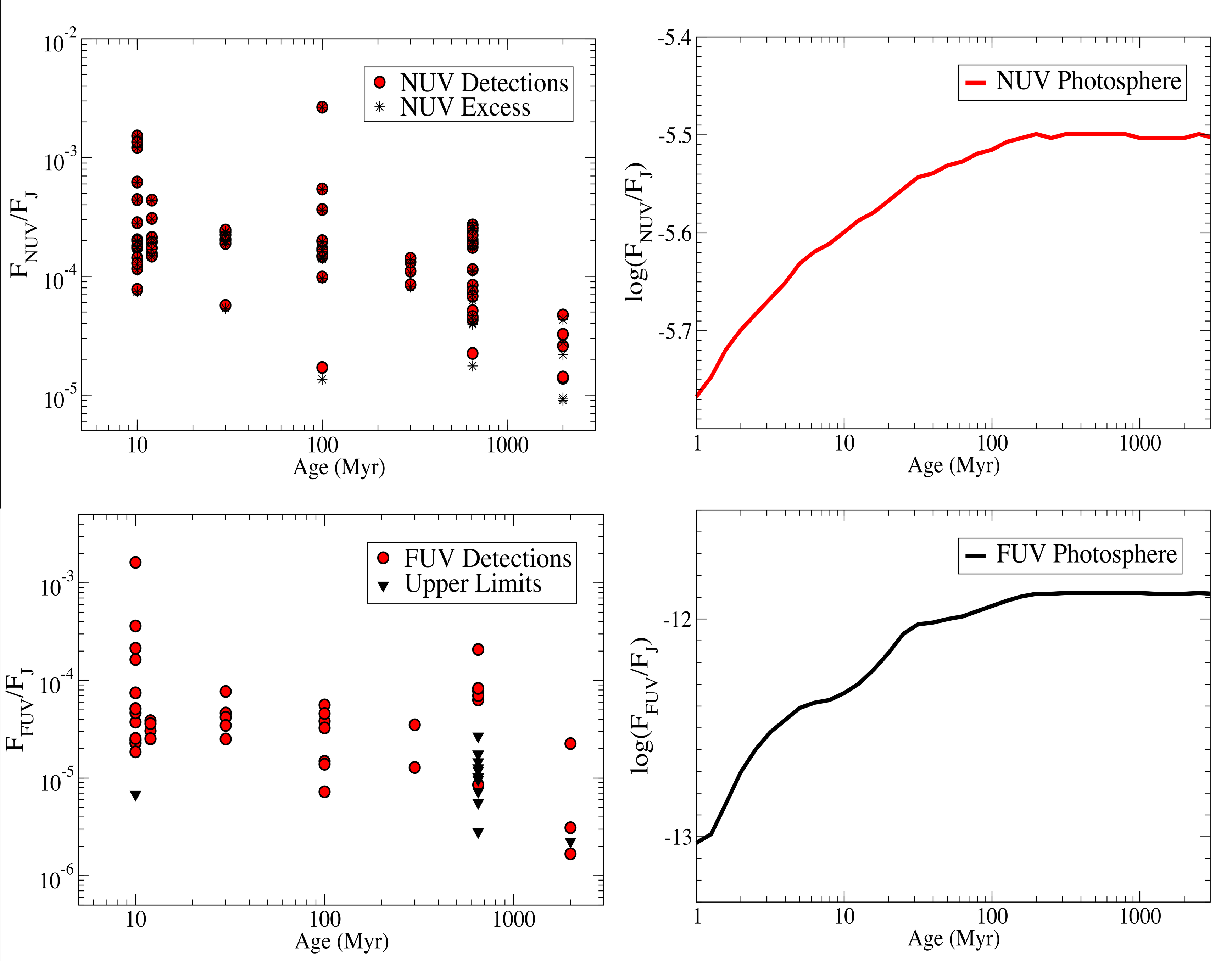
Evgenya Shkolnik & Travis Barman
Lowell Observatory

EVOLUTION OF STELLAR UV EMISSION

M dwarfs between 10 and 100 Myr are critical to understanding planet formation as this time scale coincides with the end of giant planet formation and active terrestrial planet formation. It is also in this time frame that HZ planets generate, and perhaps regenerate, their atmospheres in close proximity to their young and active host stars.



The GALEX NUV and FUV flux of a 0.3-$M_\odot$ member of several young moving groups. The activity drops by a factor of 60 and 120, respectively, from 10 Myr to a few Gyrs.



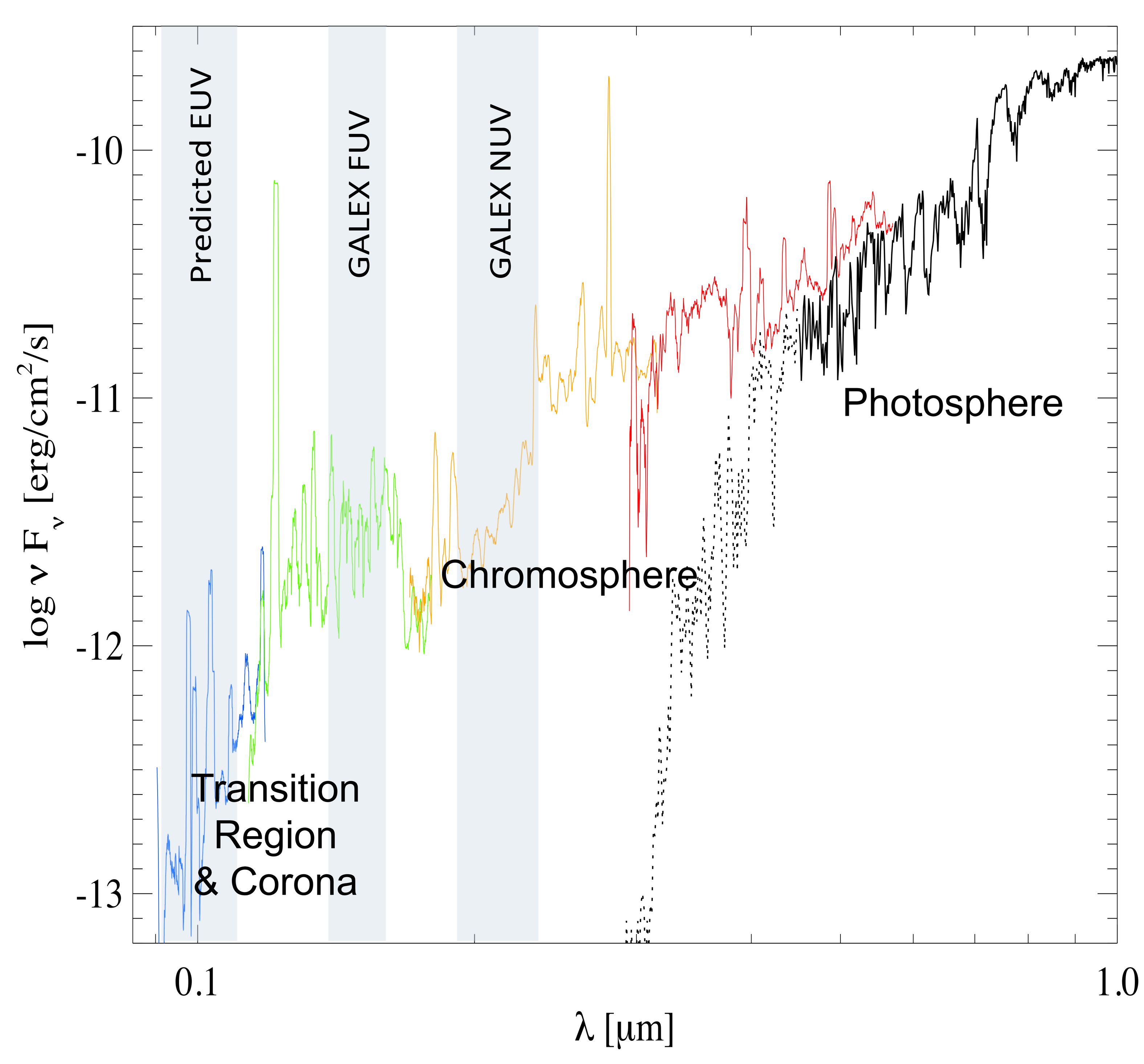
Time evolution of NUV and FUV fractional flux using all GALEX-observed early M-type (M0-M4) members of young moving groups. To the right is a representative PHOENIX stellar atmosphere model showing the evolution of the NUV and FUV photospheric flux, which at these wavelengths is negligible in all cases except for the oldest stars (this work and Stelzer et al. 2013).

PREDICTING THE ELUSIVE AND DAMAGING EUV FLUX

High FUV and EUV emission from the transition region and corona strongly affects the planet's atmospheric evolution, as it can chemically modify, ionize, and erode the atmosphere (e.g., Kasting et al. 1993), especially when HZs around M dwarfs lie at only 0.1 – 0.4 AU. Can terrestrial planets in the canonical HZ around M dwarfs be habitable?

To answer this question, we are producing an empirically-motivated upper-atmosphere profile that best matches GALEX fluxes using the PHOENIX non-LTE code. With this we can predict the EUV flux, which is currently unobservable, as a function of stellar mass and age.

UV spectra (colored) for ET Cha, a young M2 star, plus the best atmosphere model (black) published to date (Woitke et al. 2011).



We appreciate support from a NASA/GALEX grant and from M. Beckage and D. Trantow of Lowell Observatory's Advisory Board.