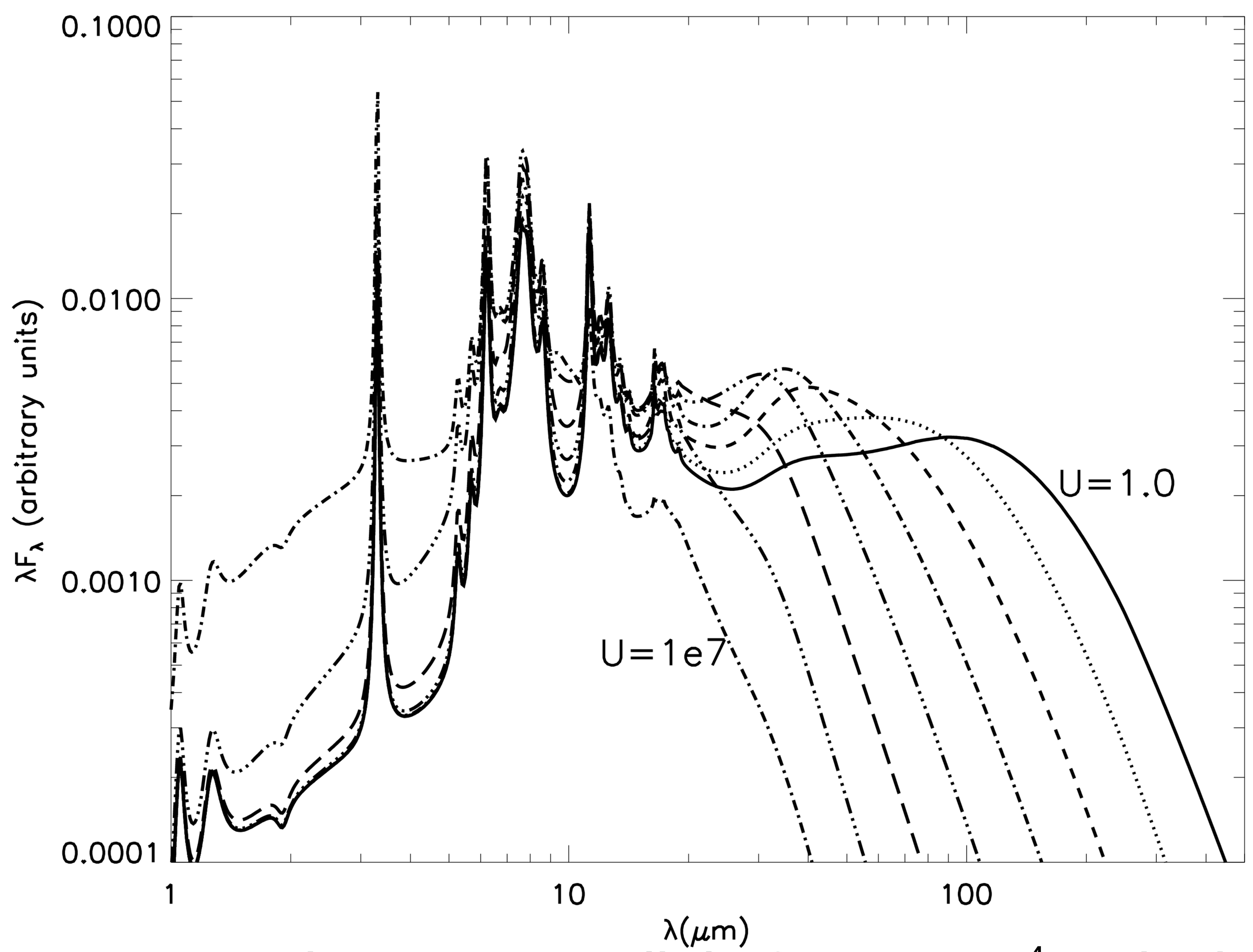
Breaking Degeneracies in Radiative Transfer Codes

David G. Whelan[1], K. E. Johnson[1,2], B. A. Whitney[3], R. Indebetouw[1] & K. Wood[4]

[1]Dept. of Astronomy, Univ. of Virginia; [2]Adjunct at NRAO, Charlottesville; [3]Space Science Institute, [4]Schoot of Physics and Astronomy, Univ. of St. Andrews

MOTIVATION: PAHs/VSGs are a realistic, but confusing, component to dust radiative transfer

Stochastic emission from *polycyclic aromatic hydrocarbons* (PAHs) and *very small grains* (VSGs) **varies according to the energy density in photons**.

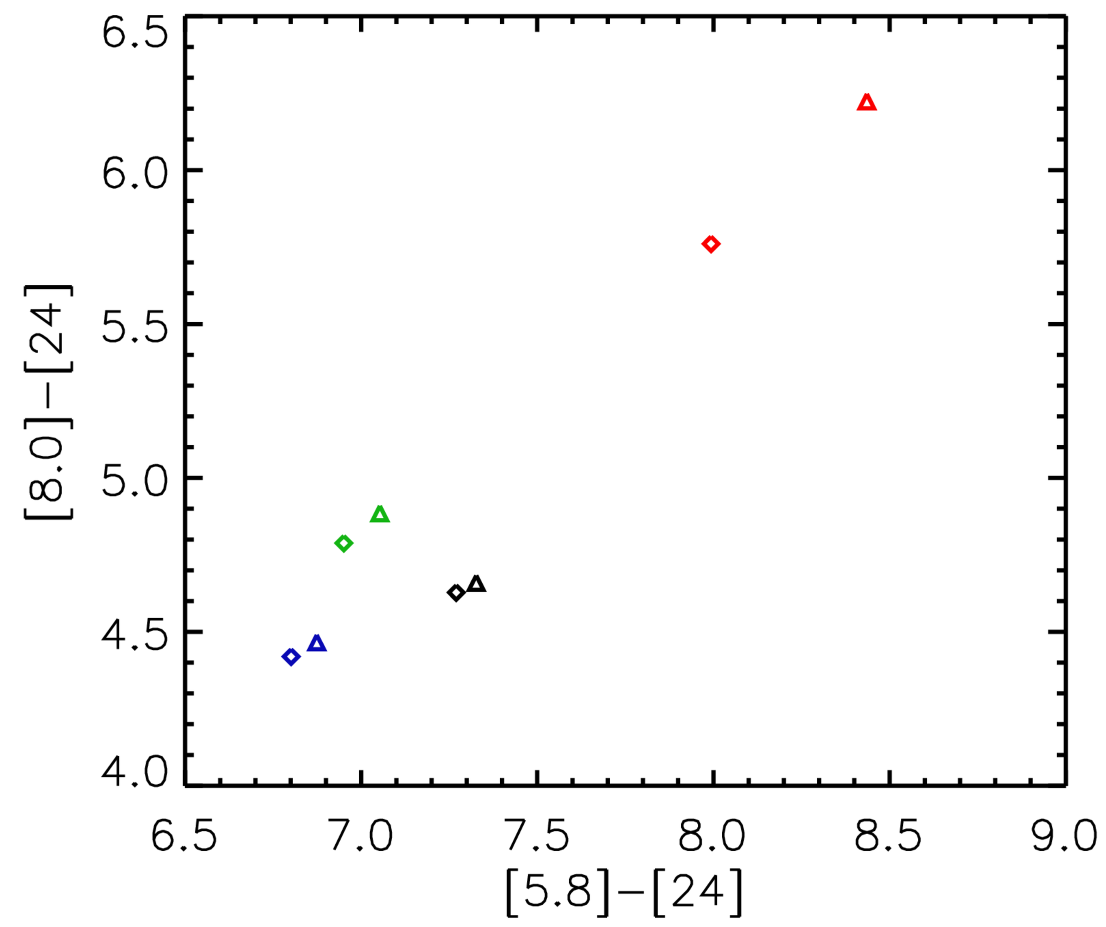


The PAH spectrum changes very little for $U < 10^4$. *U* is the radiation field energy density relative to local ISRF. These PAH templates are from Draine & Li (2007), and have been used previously by Wood et al. (2008) on Gomez' Hamburger. An important update to this code will involve a PAH/VSG template that includes ionised PAHs, so that individual features can be seen to change more drastically, and red sources, to model the PAH/VSG emission deep in the clouds realistically.

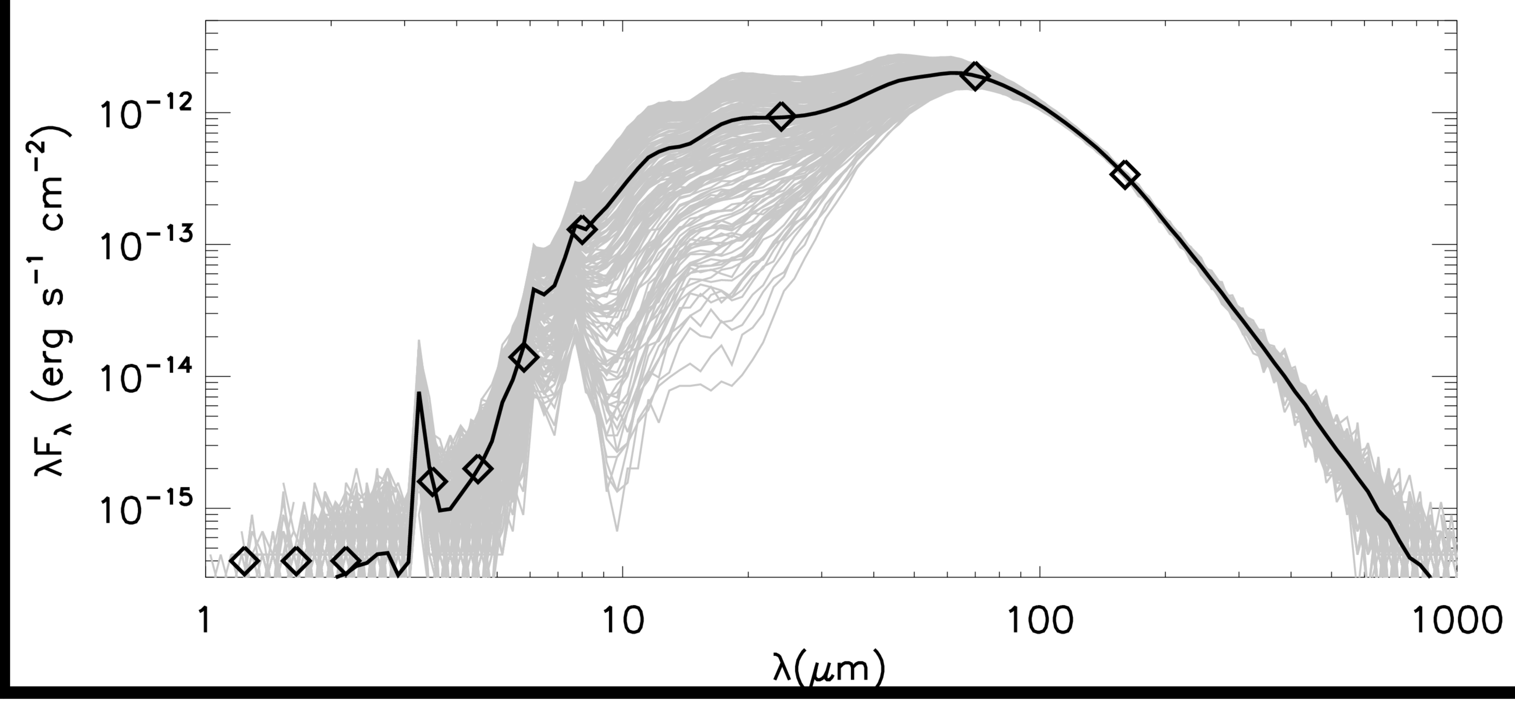
Where the PAHs/VSGs are confined to matters

Putting PAHs/VSGs throughout a cloud, rather than in the PDR only, changes the infrared colors. This difference is small up to high optical depths.
Since PAHs/VSGs are considered to be confined to the PDR, restricting the small grains to Av=1.5, while an estimate, is probably more realistic.

Diamonds are for small grains throughout, triangles for PDR only.



Black: A_V = 10
Blue: A_V = 30
Green: A_V = 90
Red: A_V = 270

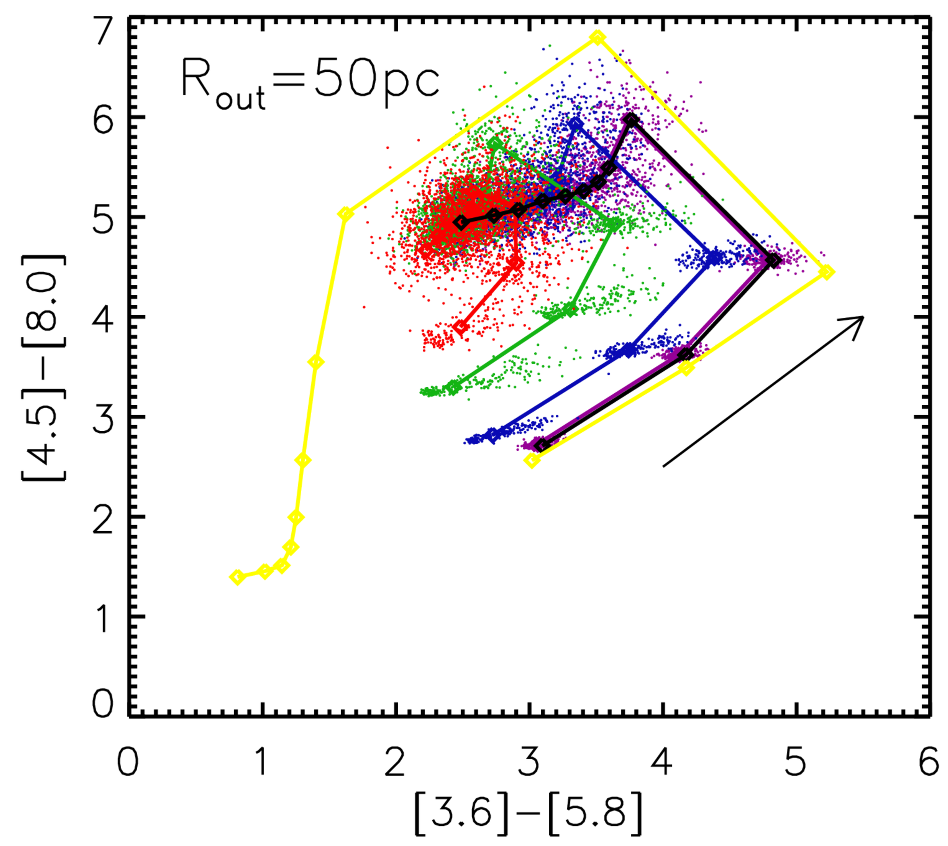


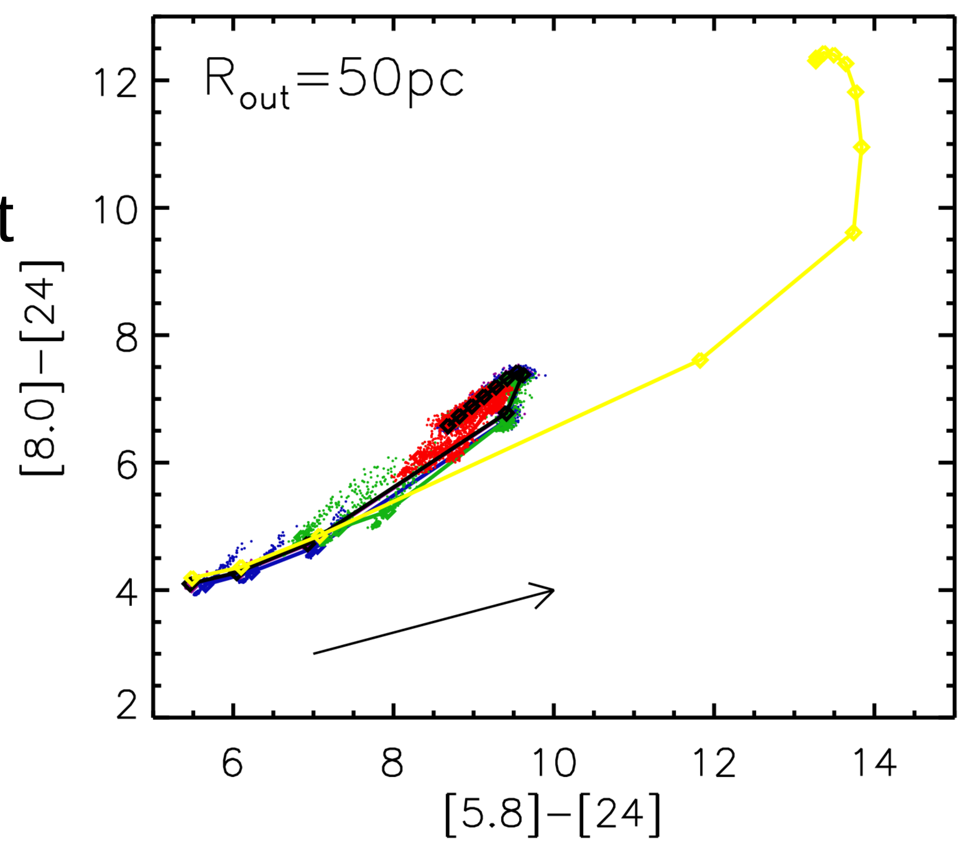
Variation in the infrared emission due to clumpiness results in the spread of data points seen in the Spitzer color-color plots below

THE IMPORTANCE OF INCLUDING PAH/VSG EMISSION

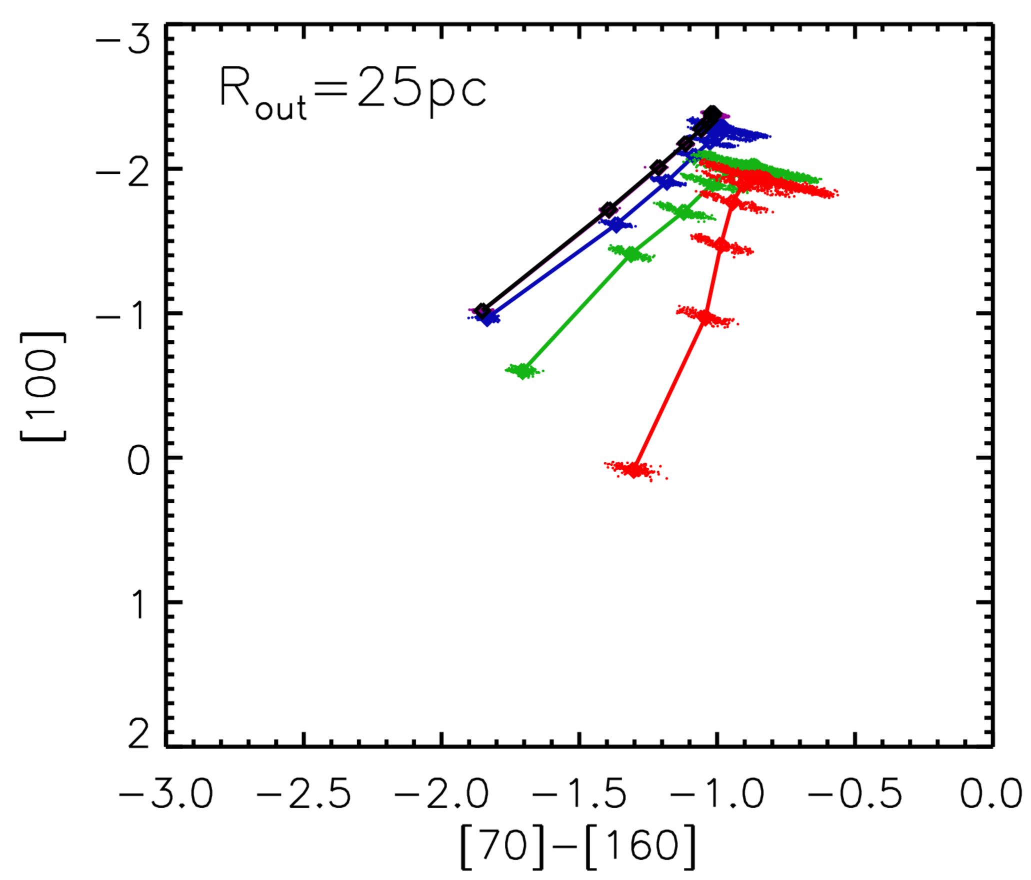
This 'evolutionary sequence' considers a point source with a varying inner dust envelope radius (outer dust radius shown in the figure). Increasing radius is indicated by the arrows. (From Whelan et al. in preparation)

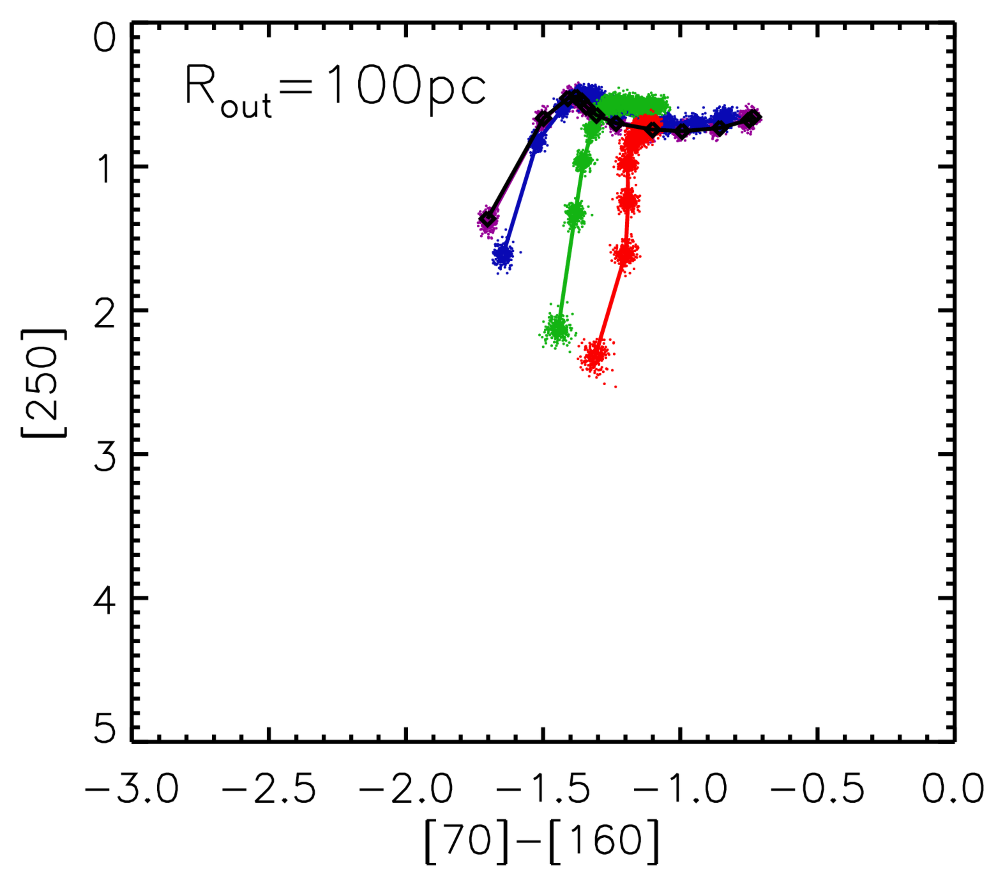
These mid-infrared (Spitzer) color-color diagrams show that models that do not utilise PAHs/VSGs (the yellow lines) are far from matching those that do. This could lead to a serious mis-interpretation of one's data.





Using **Herschel photometry** with PACS and SPIRE **will break some of the model degeneracies**, such as those created by dust clumpiness, while being negligibly dependent on the small grain emission.





The different dust distributions (completely smooth = black; 99% clumpy = red) are well-separated in these PACS and SPIRE color-magnitude diagrams, unlike for the Spitzer diagrams.