PHYS239 Homework 4

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1 Part a)

For M82 a single burst of star formation is consistent with the provided spectrum because of the fall off at short wavelengths. If there were continuous star formation, there would be a significant amount of high energy emission. The lower power from short wavelengths means a single event would have to have occurred long enough ago for the largest stars to have died. This is consistent with the outflows, which can be driven by supernovae [Fenech, et al. 2010]. All of the stellar spectra provided on the Starburst99 web page show decreasing luminosity at a wavelength of 0.1 μm. This is not consistent with the provided spectrum fro M82, and since the luminosity continues to decrease as wavelength increases, I am forced to conclude that stellar emission does not dominate any part of the spectrum, but is important at short wavelengths. It appears to produce features in the 3 to 5 μm region of the spectrum. To match the observed spectrum we require 5×10^4 $M_\odot$ star formation in the instantaneous event. This was determined by rescaling Starburst99 spectrum, which was for 10^6 $M_\odot$ star formation, to match the observed spectrum. I used the provided model an instantaneous star formation event occurring 900 Myr ago with Salpeter IMF and included nebular emission.

2 Part b)

The dust temperature was selected to match the wavelength of the peak with the prominent peak in the provided spectrum. The temperature corresponding to this is 40 K. The shape of the spectrum could be fit with many different size and composition combinations. I ended up choosing silicate dust grains that are 1000 μm in size. Dust emission dominates from about 20 μm to 2000 μm. In the plot, dust emission stops at 1000 μm because that is the limit of wavelength values in the dataset provided on Draine's web page linked in the assignment.

3 Part c)

To reproduce the observed long wavelength emission from M82, a power law slope of 2 was chosen. Synchrotron emission dominates from 2000 μm to the long wavelength end of the provided spectrum at around 5×10^4 μm.

4 Part d)

For the free-free emission I chose a gas temperature of 10^4 K in accordance with the temperature for HII regions provided in Draine's textbook on the ISM and IGM [Draine, 2010]. This emission is important at shorter wavelengths, from around 0.2 μm to 20 μm. Note that I have cut off the spectrum at 100 μm. This is motivated by the long wavelength shape of the provided spectrum, which would be dominated by free-free from 500 μ to 5×10^4 μm if I plotted it over the entire wavelength.

References

[Draine, 2010] Draine, B. T. (2010). Physics of the interstellar and intergalactic medium. Princeton University Press.

[Fenech, et al. 2010] Fenech, D., Beswick, R., Muxlow, T. W. B., Pedlar, A., & Argo, M. K. (2010). Wide-field Global VLBI and MERLIN combined monitoring of supernova remnants in M82. Monthly Notices of the Royal Astronomical Society, 408(1), 607-621.