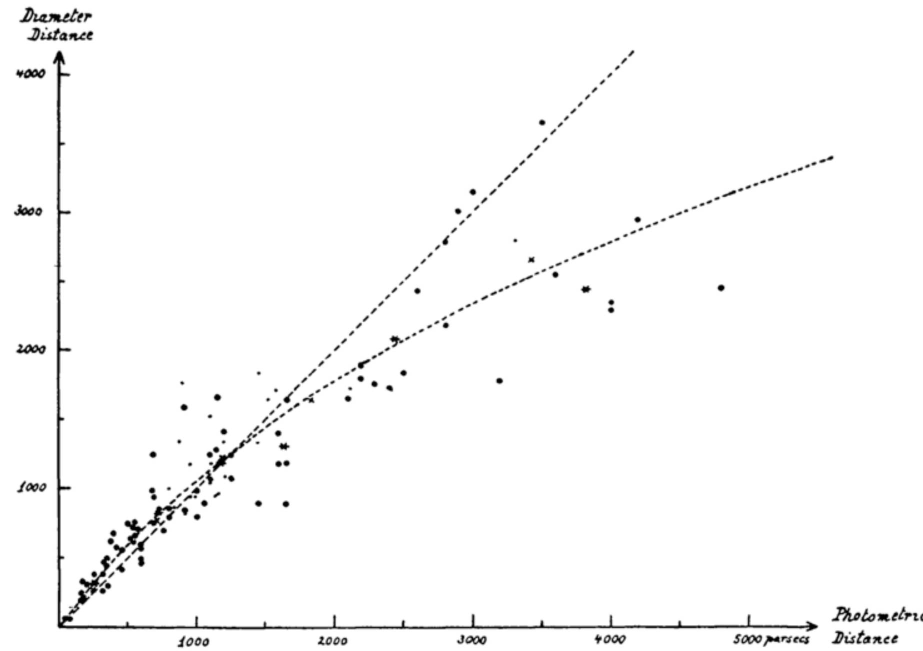
Dust Maps

Interstellar Dust

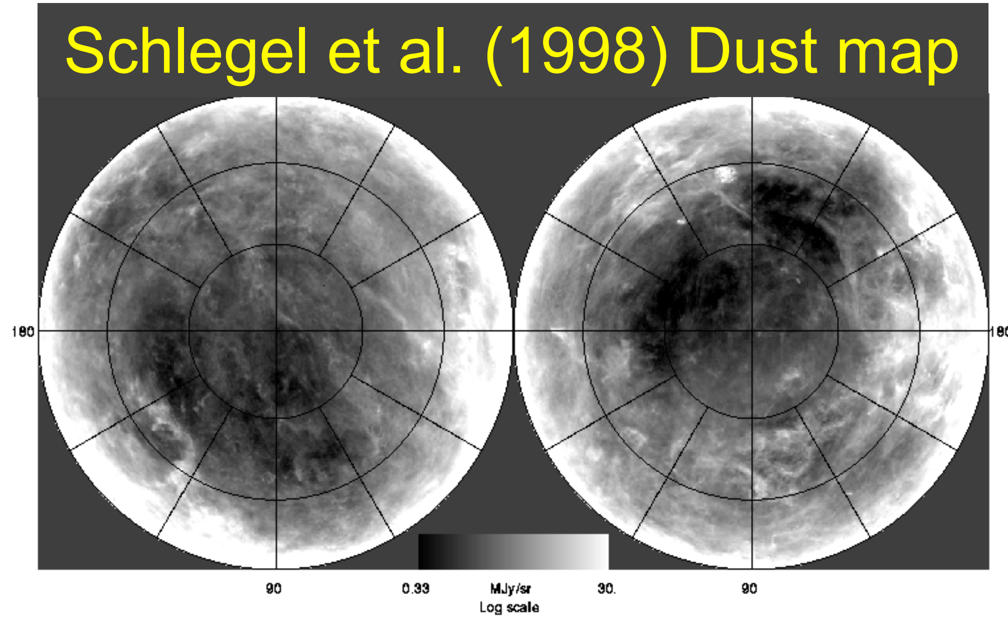
- Robert Trumpler first confirmed the existence of interstellar dust (1930; see syllabus link and, in particular, point 5 of the Summary on page 187)



- Trumpler noticed that open star clusters of the same general apparent size had different brightnesses
- Either the real size of clusters increases farther from the Earth (i.e. the Earth is in a special location), or stars become progressively *fainter* at larger distances
- Absorption by interstellar dust would make stars progressively fainter with distance from the Earth

Dust Maps

- Now, the third most cited journal paper in astronomy deals with the careful mapping of interstellar dust
- Schlegel et al. (1998; see syllabus links)



- The paper is well-cited because any measurement of the flux (or magnitude) from extragalactic sources must correct for foreground absorption by dust in our Galaxy
- To correct a magnitude for dust, subtract the extinction (A) in that band ($m_{true}=m_{observed} - A$; additional equations for interstellar reddening are linked from the syllabus)

Dust Maps

- You will need to install *sfdmaps*. You can do this with *pip install sfdmap* in the command line.
- And download the SFD maps. In your week4 directory: *git clone https://github.com/kbarbary/sfddata*
- Make sure that you do not add the *sfddata/* directory to our repository tracking!
- Now you can use the *sfdmap* package and *astropy.coordinates* to access the maps:
- Convert (RA, Dec) to Galactic coordinates:
  - *ra, dec = '00h42m30s', '+41d12m00s'*
  - *c = SkyCoord(ra, dec).galactic*

Dust Maps

- Obtain the reddening at this position from the dust maps
  - *import sfdmap*
  - *dustdir = './sfddata/'*
  - *m = sfdmap.SFDMap(dustdir, scaling=1)*
  - *ebv = m.ebv(c.l.value,c.b.value, frame='galactic')*
- Note that it is also possible to obtain the reddening without first converting to Galactic coordinates, e.g.
  - *ra, dec = '00h42m30s', '+41d12m00s'*
  - *c = SkyCoord(ra, dec)*
  - *ebv = m.ebv(c.ra.value,c.dec.value)*

Dust Maps

- Finding *extinction* requires wavelengths and a dust-law from the *extinction* package.
- Install the extinction package: *pip install extinction*.
- To find ***rough*** extinctions for the SDSS *ugriz* filters (more on *ugriz* later):
  - *import extinction*
  - *wave = np.array([3543., 4770., 6231, 7625., 9134.])*
  - *A = extinction.fitzpatrick99(wave, 3.1*ebv)*

Python tasks

1. The objects at $(\alpha,\delta) = (246.933^o, 40.795^o)$ and $(236.562^o, 2.440^o)$ are both quasars near a redshift of $z = 1.08$
   - Use the *SDSS Navigator Tool* linked from the syllabus to obtain the magnitudes of these quasars and plot $g - r$ versus $r - i$ for both quasars in the same plot
   - Do the quasars have similar colors? Should they?
   - Correct the quasars' magnitudes for Galactic extinction and re-plot them. Do their colors now agree better?
2. Let's visualize the dust in the region of each quasar
   - Use *numpy.meshgrid* to make a 2-dimensional 100 x 100 array (i.e. a grid) centered near $(236.6^o, 2.4^o)$ with 1^o bins. Create another set centered at $(246.9^o, 40.8^o)$ for RA in $\mathbf{1.3^o}$ bins and for DEC in 1^o bins.

Python tasks

3. Convert your RA/DEC 100 x 100 arrays to Galactic (*l*, *b*)
4. Using matplotlib's *contour* procedure (linked from the syllabus), let's plot dust maps
   - Find the amount of reddening *E(B-V)* at each *position* in your 100 x 100 arrays.
   - Make a contour plot:
     – *cs = plt.contour(RA, Dec, ebmv)*
     – Think about appropriate contour levels.
5. On your plots, also show the position of each quasar and a line in RA/Dec depicting the Galactic Plane (a line from $l = 0^o$ to 360^o; *np.arange(360)*; at $b = 0^o$; *np.zeros(360)*]