Introduction to Astronomy
Summary Questions Week 12

6 January 2020

1. What are the four main phases of the ISM?

   Solution:
   The four main phases are:

   1. the *Hot Ionised Medium (HIM)*
   2. the *Warm Ionised Medium (WIM)*
   3. the *Warm Neutral Medium (WNM)*
   4. the *Cold Neutral Medium (CNM)*

2. What is the origin of the HIM and where is the HIM located in the Galaxy?

   Solution:
   The HIM is created through ionisation of the interstellar gas by *supernova explosions*. This means it is typically found in *compact supernova remnants or extended (super)bubbles*, although there is a larger component that forms a *halo* around the Galaxy.

3. Where does the WIM come from and where is it found?

   Solution:
   The WIM has two origins: partly it is *a cooled-down part of the HIM*, partly it is interstellar gas that is *ionised by the UV radiation of hot, massive stars (types O and B)*. It consists of a *diffuse component surrounding the Galaxy* and in more localised *HII regions surrounding young massive stars*.

4. What causes the 21-cm line of neutral hydrogen?

   Solution:
   An *electronic spin-flip*. More specifically, if the spins of the proton and electron are parallel, the atom has a slightly higher energy level than if they are anti-parallel. So when the electron changes its spin from alignment to anti-alignment, a low-energy photon is emitted, with a wavelength of 21 cm.

5. What is the importance of the Cold Neutral Medium?

   Solution:
   The CNM is the *coldest part of the ISM*. It is, therefore, the phase in which *molecular clouds are created*. This in turn is of key importance for the ISM because molecular clouds are the places where *star formation occurs*.

6. What dual role does interstellar dust play in astronomy – and what is observationally the problem with dust?

Solution:

Dust is important because *1) it absorbs UV radiation and thereby shields complex molecules*; and *2) it functions as a catalyst allowing the formation of (complex) molecules.* Observationally dust causes a problem because of its *absorption*: dust is the reason why in many parts of the electro-magnetic spectrum (and most importantly in optical, UV and IR), we cannot see very far, especially not inside the Galactic disk.