WHY IS O2 PARAMAGNETIC WHILE N2 DIAMAGNETIC?

I hope you have seen the video of the link I had given you in previous post. Did you notice that Oxygen somehow dances between the poles while Nitrogen escapes? This strange behaviour can be explained by MOT.

You can see Oxygen gets attracted toward the magnetic field while Nitrogen repels it. In both cases N_2 and O_2 behave like a magnet. You may get surprised here and ask, how can I relate a molecule to a magnet? You must have learnt in physics that magnetic field is associated with moving charged particle. Similarly in molecules moving negatively charged electrons generate a magnetic field. Thus, the magnetic behaviour of an atom or a molecule is related to the orbital and spin motion of its electrons. Quantum number m_l and m_s represent the magnetic factor of an electron.

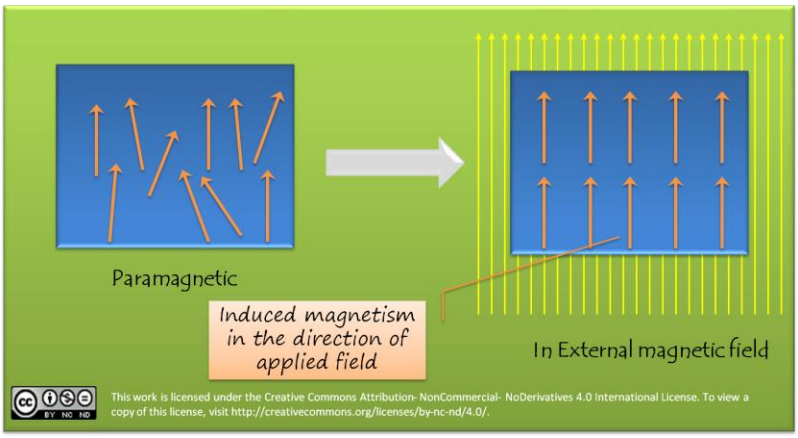
That means the reason behind their strange behaviour lies in their electronic arrangement. So, have a look on electronic configuration of N_2 and O_2 again.

Electronic configuration of N_2: $\sigma 1s^2$, $\sigma^* 1s^2$, $\sigma 2s^2$, $\sigma^* 2s^2$, $\{\pi 2py^2, \pi 2pz^2\}$, $\sigma 2px^2$

Electronic configuration of O_2: $\sigma 1s^2$, $\sigma^* 1s^2$, $\sigma 2s^2$, $\sigma^* 2s^2$, $\sigma 2px^2$, $\{\pi 2py^2, \pi 2pz^2\}$, $\{\pi^* 2py^1, \pi^* 2pz^1\}$

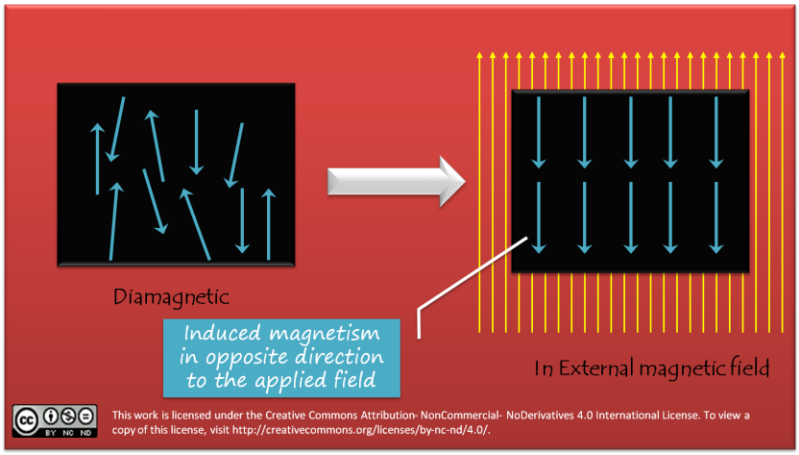
You can see that in N_2 all electrons are paired while O_2 has 2 unpaired electrons. These unpaired electrons are responsible for the magnetic nature of O_2.

These unpaired electrons of O_2 move around in their orbits. Their orbital motion generate loop of current which produces magnetic field. You may think that both unpaired electrons spin in clockwise direction so their magnetic field will add to give a strong resultant magnetic field which makes O_2 a powerful magnet. But it doesn't happen because these electrons are randomly arranged in a molecule so they cancel each-other's magnetism and very little magnetism is left within a molecule.

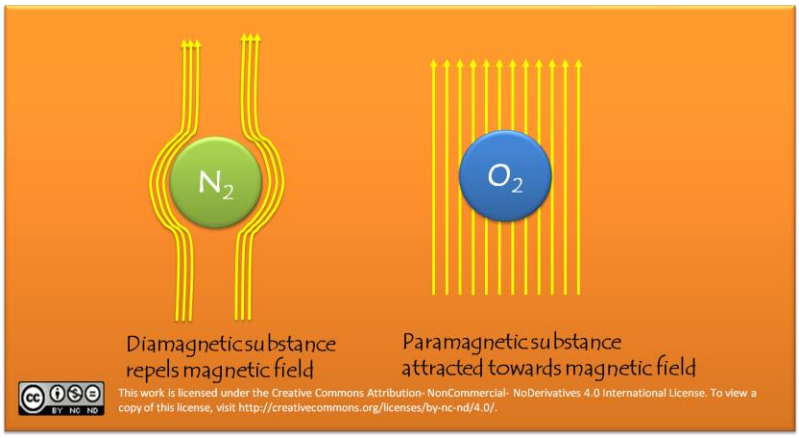


As we apply external magnetic field these tiny magnets get aligned in the same direction as the external magnetic field thus they produce induced magnetism in the direction of applied field which is proportional to the applied field. That's why O_2 get attracted towards external magnetic field. This type of magnetism is called paramagnetism.

In case of N_2 molecule, all electrons are paired. That means half of the electrons spin clockwise and half of the electrons spin anticlockwise. Because of their opposite spins they produce magnetic field in opposite direction thus the resultant magnetism becomes zero. When such molecules are placed in an external magnetic field they produce induced magnetic field in opposite direction and that's why they repel the magnetic field. This type of magnetism is called diamagnetism.



Actually all atoms/molecules are diamagnetic inherently but the presence of unpaired electrons produces some magnetism in the atoms/molecules and make them paramagnetic. Paramagnetic molecules get attracted towards external magnetic field and diamagnetic repel the external magnetic field.



You can easily predict the magnetic nature of any molecule/atom by its electronic configuration. If it has any unpaired electrons it will be paramagnetic and otherwise it will be diamagnetic.In the next post we will see how MOT deals with the molecules formed by two different elements.

Source : http://chemistrynotmystery.blogspot.in/2014/09/why-is-o2-paramagnetic-while-n2.html