AAS : Notes for Discussion 9th September, 2019

Potential topics for our Discussion Group

Topic 1

Expansion of the Universe : 100 years (or so) of theory and observation.
We have gone from an expanding universe, Hubble 1929, to an accelerating universe in 1998.
What new insights or conclusions have the last 20 years brought?

1922:- Alexander Friedmann published a series of equations showing that the universe might be expanding and estimated what the expansion speed might be.

1927:- George Lemaitre published a paper in which he claimed that the recession of distant objects could be explained by a theory of an expanding universe. Observed a proportionality between recessional velocity and distance to nebulae and estimated a value for this constant.

1929:- Edwin Hubble confirmed observationally the existence of cosmic expansion. Determined an expansion constant from the redshifts of distant objects, known as the "Hubble Constant".

1998:- two teams of cosmologists were observing many distant supernova. Their results seemed to suggest that, rather than the expansion rate slowing down under the influence of gravity it was actually speeding up.

So, contrary to the accepted matter dominated view of the time the expansion of the universe is accelerating.

They therefore deuced that there must be a repulsive force that is driving this acceleration. They termed it "Dark Energy".

2019:- Now recent research has indicated that the rate of expansion is faster than the standard model of the universe predicts.

Some questions that could be asked:-
What is the Standard Model, what is the Hubble constant that is being measured, what are the standard candles used for estimating distances, what is the discrepancy that threatens the standard model that the cosmologists are concerned about? Where do we go next?

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2 : Dark Matter:

Did DM exist before the "Big Bang" and has an Italian experiment (DAMA/LIBRA) detected the Earth moving through the assumed Milky Way DM cloud?

The Milky Way is a flat disk with a central bulge. Right? Apparently not. A new study by astronomers at the Uni of Warsaw suggests otherwise. "Our map shows the

Milky Way disk is not flat. It is warped and twisted far away from the galactic center," said co-author Przemek Mroz. The cause is unknown but they suggest a possible near collision with another galaxy or the dreaded Dark Matter.

3 : Missions:-

The Parker Solar probe has now made 2 close passes to the sun in its 7 year mission and has downloaded 25GB of data. Plenty of analysis to fuel a few more PhDs.

Ever wondered how NASA estimated the size and shape of the Kuiper Belt object Ultima Thule before they took a photo? It was by star occultation.

After many delays and cost over runs the 20 year old James Webb space telescope is finally being assembled. Now due for launch (maybe?) in 2021.

Another project, the world's largest radio telescope, the Square Kilometre Array, is also suffering from cost hikes and delays. It is now being reduced in size but the team hope to start construction in 2021. Completion date, who knows?

A few months ago NASA launched an atomic clock into orbit. This is a result of significant miniaturisation reducing the size of the device from that of a double fridge to that of a toaster. If successful it will be of most use in deep space missions reducing the need for the spacecraft to communicate back with earth based clocks.

One mission it may well be suitable for is the Europa Clipper mission which has just had approval for the final design stage. It is planned to investigate Europa, one of Jupiter's moons. Europa is thought to have a water ice crust overlying a water ocean which could/may contain life.

4 : Evolution of Stars & Galaxies

The earliest stars, known as population III, were large, comprised of mainly H and didn't last long. The next generation formed from the supernova of the early stars began to have very low levels of heavier elements. Now astronomers have found such a population II star only 35,000 light years from earth. We know it is a very early star from its low metallicity, that is anything that isn't H, He or Li. For example its iron content is 1.5 million times lower than the sun (which is probably 100 generations old) and it would have been formed within a few hundred million years of the Big Bang.

Using a new technique 39 ancient galaxies have been identified. The discovery doesn't fit well with current models of the universe and much is hoped to be learnt from further research.

5 : Black Holes

There has always been a conflict of theories as to how stellar black holes formed. Gravitational wave observations from LIGO have added to this debate and now a black hole around 100 solar masses may have been found. This is way above the supposed limit of 50 solar masses that had been presumed. The race is now on to find out how a black hole can be so much bigger than theory predicts.