Dear Cheap Astronomy - Episode 008, Thinking big.

Question 1:

Dear Cheap Astronomy – Hubble or Lemaitre?

Good question. In terms of firsts it was probably Lemaitre, although Hubble is the one who came up the most convincing evidence.

The issue we are dealing with here is who first determined that the Universe was expanding. As it happens, in 1912, Vesto Slipher, an American astronomer born in Indiana, determined that the light from a number of spiral nebulae was red-shifted due to their receding velocity. So, we should note that Slipher was the first person to determine that distant galaxies were red-shifted, he just didn't know that the nebulae he was measuring were distant galaxies.

Anyhow, the Belgian physicist and astronomer, Georges Lemaitre, who trained as a priest but also worked as a graduate student at the University of Cambridge with Arthur Eddington, had a good understanding of Einstein's general relativity when he began looking at Slipher's data.

He published a report in 1927 entitled (after translation) A homogeneous Universe of constant mass and growing radius accounting for the radial velocity of extragalactic nebulae. In the report, he outlined what is now called Hubble's Law and he made the first calculation of what is now called the Hubble Constant.

Lemaitre actually sent his work to Albert Einstein asking for comment. Einstein's reply was somewhat scathing: Your calculations are correct, but your physics is atrocious. Of course, this preceded Einstein's forehead-slapping realisation of his so-called biggest blunder. Einstein did later acknowledge that Lemaitre had done some outstanding work, although Einstein also seemed to go along with the prevailing view that Edwin Hubble had made the real discovery of the expanding universe.

Another person who may tie several threads of this story together was the Dutch astronomer and physicist Willem De Sitter, who was a close contemporary of Einstein and before 1920 had himself developed an expanding universe solution to Einstein's field equations. Apparently De Sitter had also became interested in Vesto Slipher's red-shifted nebulae data in the early 1920s.

Then, allegedly, De Sitter met Edwin Hubble at an astronomy conference in 1928 and talked Hubble through some of the prevailing theoretical views that were being bounced around at that time. Allegedly, Hubble then returned to the US determined to test the ideas that De Sitter had discussed. In 1929, Hubble announced his own data that confirmed a linear relationship between the distance and the red-shift of different nebulae. This is became known as Hubble's Law – and the rate of change, that is the gradient of the linear relationship, became known as Hubble's Constant.

Hubble was undoubtedly a darn-good astronomer and was fortunate to have access to the 100-inch Hooker Telescope, probably the world's most powerful telescope of the day. He had already announced, in 1924, the profound discovery that distant nebulae were positioned far outside the known dimensions of the Milky Way. So, in 1929 Hubble was well placed to promote the expanding universe in a way that Georges Lemaitre never could have.

Indeed Lemaitre seemed happy to renounce any prior claim, deliberately omitting his own estimations of the so-called Hubble Law and Constant, when his 1927 paper was translated into English around 1930. In any case, Lemaitre is generally credited with originating the concept of the Big Bang, which he did around 1932, so he holds a key place in cosmological history anyway.

Albert Einstein, who had pretty much started this whole business, visited Edwin Hubble at Mt Palomar in 1931. This turned into a bit of a media event and hence further cemented the public view that it had been all about Hubble.

Although, allegedly, when a reporter told Einstein's wife Elsa that the giant Hooker telescope had been used to determine the nature of the universe, she replied: "Well, my husband does that on the back of an old envelope."

Question 2:

Dear Cheap Astronomy: Since space and time began at a Big Bang singularity and expanded in all directions, why is there no centre in our Universe? John from the UK.

Hi John - thanks for another great question.

But it's hard to give you an answer that won't seem a bit unsatisfactory. Perhaps the best answer to this question is that you can't ever hope to measure where the centre of the Universe is - so it becomes kind of pointless asking about it.

Firstly, it's important to appreciate that we are, and we always have been, at the centre of our observable universe. This just means that we can look out in any direction and, in doing so, look back to some of the earliest observable parts of a much younger and much smaller observable universe.

But we have to face the fact that we will never see, or travel beyond, this observable universe. We can still observe distant regions of it, as those regions were when they were much younger. But we know that those distant regions are now, like today now, moving away from us faster than the speed of light - due to the cumulative expansion of the universe over billions of years.

Nonetheless, it is quite plausible that there is more universe out there that extends far beyond the limits of our observable universe. It is statistically unlikely that our observable universe is in the centre of that much larger universe, but we are never going to know whether it is or not.

Any discussion about the centre of the universe will always seem kind of frustrating and unsatisfactory because, being humans with our well-developed visual and spatial perception, we are instinctively drawn to the idea that there should be a centre.

For example, you can try to imagine some point outside of the universe from which we could observe the whole universe from a distance and then be able to identify a point within it that represents its centre.

But if you think about it, this is nonsensical. If you are outside the universe, there is no space-time, so light can't travel to your eye to allow you to see the universe in the first place. And even theoretically, if you tried to observe from a distance something which has opposite edges that are expanding away from each other at faster than the speed of light, then you could never hope to make a proper determination that thing's width. Regardless of when and where you chose to determine the position of its near edge, the far edge would have already moved beyond your perception.

So the only way to measure the dimensions of the universe is from inside the universe and then your perception becomes limited to the spherical bubble of your own particular observable universe - and that's that. We have to acknowledge that the actual dimensions of our universe are unknowable - and hence the position of its centre is also unknowable.

Part of this problem is that the theoretical edges of our universe are expanding away from us faster than light. But even if we imagine a closed universe, in which the cumulative gravity of that universe's contents is sufficient to drag space-time back down into a Big Crunch, you would still not be able to find, or measure, the location of its edges.

The space-time of a closed universe is curved in upon itself. So, for example, if you attempted to fly out towards that universe's edges your world-line geodesic would get curved back around so that you might find yourself coming back to where you started from. Alternatively, if you just used a telescope to look outwards then, in a small closed universe and with the right magnification, you might find yourself looking at the back of your head.

So it's not so much that the universe doesn't have a centre, as that its centre is unmeasurable and unknowable. From there it becomes a question of whether something that is unmeasurable and unknowable can really be said to exist.

And if you didn't like that answer much, we could just tell you that if the universe really did expand from a single point - then everything that came from that single point must all still be the centre. It's just a much bigger centre now.