Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this *Situation Cloudy.*

Here’s a quick guide to observing the Large and Small Magellanic Clouds next time you’re in the southern hemisphere. In Australia and elsewhere they are easily seen with the naked eye in dark skies. That is to say, in a light polluted city, they are usually invisible – but in a country town, they should be easy to see.

The Clouds are both circumpolar, at least in lower southern latitudes, so they rotate around the southern celestial pole without ever setting below the horizon. They really are a breath-taking sight and well worth going to a bit of trouble to see, but you do need to get out of the city.

Anyhow, it seems that these Clouds are a little unusual. The Milky Way seems to be somewhat unique in having two such visible dwarf galaxies around it. Most sky surveys to date don’t find a lot of dwarf galaxies around other large galaxies. This is itself a bit odd, since the standard model for galaxy formation assumes large galaxies grow by consuming smaller, dwarf galaxies.

For a galaxy to stay bright, it has to keep eating new gas and dust – or otherwise it quickly becomes filled with older stars which still shine but are generally members of the fainter red spectral classes – as opposed to bright white-blue, but short-lived, spectral classes. So you’d think any large bright galaxy would be surrounded by dwarf galaxies on a slow spiral path to assimilation – but strangely, we don’t seem to see this much.

Of course it may be that these dwarf galaxies - on a path to assimilation - really are out there – but just very hard to see if they’re quite faint objects against a bright background.

So perhaps what’s really unusual here is why the heck the Magellenic Clouds are so bright? It's unlikely to be because they are actively consuming new gas and dust – if they had spent their lives on such a diet they wouldn't be dwarfs any more - and even if they are just starting chowing down on some peripheral gas and dust around the Milky Way - then why don't we see lots of similar bright dwarf galaxies around other large galaxies.

And so – welcome to the ongoing detective story that is the Magellanic Clouds.

Firstly, many people think the Clouds are just passing through. Measurements of their velocity taken by the Hubble Space Telescope suggest that at around 300 kilometers a second, they are moving way too fast to be captured into a bound orbit by the Milky Way. So, they're just there now – like ships passing in the night - eventually to depart off into intergalactic space.

As a casual observer from the southern hemisphere, it’s tempting to respond to this notion with – *Are you kidding me? They’re right there, dude. Check it out.*

And maybe this viewpoint has some scientific validity. It's always contentious when you have to draw a conclusion from an observed value - which is real, objective data – but then compare this with your expected value, which is largely a human construct informed by your theory, your mathematics and the limits of your imagination.

And of course any astronomer would acknowledge that you need to have a substantial level of confidence in your theory, your mathematics and your imagination to come to the conclusion that the value you expected - say the calculated escape velocity of a Magellanic Cloud - is genuinely less than the observed value - that you measured with the world famous Hubble Space Telescope. *I mean dude it's the Hubble - how could that be wrong?*

And of course, the Hubble probably isn't wrong. The debate isn't about the Hubble Space Telescope's observed value, it's about whether the expected value for the Clouds' escape velocity has been correctly estimated - and woah baby let's think about all the possible margins of error there. Well, in fact I could just sum up the whole problem in two words - dark matter.

As you probably know, dark matter is a hypothetical - but seemingly necessary mass component of a galaxy – necessary as the only way we can currently explain how galaxies hold together, at least within the context of our current understanding of physics, and of astrophysics.

So now try to calculate the escape velocity from the humungously massive Milky Way, which isn't like a well defined spherical planet, but instead is a diffuse rotating collection of stuff of which about 90% is invisible. It’s a bit tricky.

If all the invisible dark matter is near the centre of the Milky Way then the Magellanic Clouds probably are moving at escape velocity, but if a lot of that invisible mass is spread in a halo around the periphery of Milky Way (which is actually the currently favored theory) - then maybe the Cloud's aren't moving fast enough to escape. Different mathematical models for the galaxy have shown that the Cloud’s Hubble Space Telescope-measured velocities could be accommodated just by assuming different distribution of the Milky Way’s dark matter – and when you run the numbers, these models suggest that both Clouds are not only in bound orbits, but have actually orbited the Milky Way several times already.

As to the problem of why the Clouds are bright – this is largely clarified in radio astronomy observations which have identified a 600,000 light year long stream of hydrogen gas trailing behind the Clouds – which is called the Magellanic Stream. In radio light you can also see more gas between the Clouds, called the Magellanic Bridge - and yet more gas in front of the Clouds which is being drawn into the halo of the Milky Way and is called the Leading Arm. A bit of spectroscopy reveals that most of this material arises from the Small Magellanic Cloud - which needless to say has the smaller mass of the two Clouds.

Both sides of the debate – about whether the Clouds are passing through or whether they’re in bound orbits - do agree on one point. That about 2.5 billion years ago the two once quite separate Clouds passed much closer to each other than they are now and the faster moving Large Magellanic Cloud began to drag the Small Magellanic Cloud behind it. The Small Cloud with less self-gravity and less capacity to hold itself together, left a 600,000 light year long skid mark across the Milky Way as it was dragged into a binary partnership with the Large Magellanic Cloud. And it's this gravitational disturbance event that triggered a temporary riot of new star formation within both Clouds - turning them into uncharacteristically bright dwarf galaxies.

The extra hydrogen gas arising from the collision that now forms the Leading Arm stretched out ahead of the Large Magellanic Cloud's orbital path, does appear to be being sucked down in to the Milky Way – actually at about the point where we see the Southern Cross in the sky. This certainly fits the idea that, not only are the Cloud's bound in an orbit around the Milky Way - but the process of assimilation has already begun.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where nearly every cloud has a 21 centimeter absorption lining. No ads, no profit, just good science. Bye.