Picture **this**

The Galaxy in a Bubble

Galaxies leave a trail of devastation in their wake, as this latest image from a talented pro-am collaboration reveals.

We've featured the astrophotography of US imager R Jay GaBany in the magazine before, not just because of the wonderfully deep and detailed nature of his images, but also because of his collaboration with a team led by Dr David Martinez–Delgado of the Max Planck Institute for Astronomy in Germany that highlights what can be accomplished when well-equipped, dedicated and skilled amateurs team up with professional astronomers.

This international collaboration is focused on detecting the faint remnants of dwarf galaxies that have been pulled, twisted and ripped to pieces before merging with larger spirals. Such events are not just a curiosity of intergalactic dynamics; that they occur at all is a prediction of our standard view of the Universe, dark matter and how galaxies form.

There's a hierarchy involved in galaxies. Smaller ones often find themselves as mere fodder for the larger ones, allowing them to grow. Furthermore, the larger galaxies such as the spiral NGC 3521, pictured here, don't have to go far to find their food – our models of how dark matter operates predicts that these dwarfs should lurk in their dozens in the haloes of larger galaxies, like snacks to be taken off the shelf.

Matter attracts other matter through gravity. Even though we can't see it, smell it, taste it or touch it, nor do we even know what it is made from, dark matter can be felt through its gravity. In the first few hundred million years after the big bang, the normal 'baryonic' matter of protons, neutrons and electrons – the stuff that makes everything in our everyday world – was attracted to the even larger clouds of dark matter, settling into the centre whilst the dark matter formed a giant invisible halo. Large spiral galaxies coalesced inside these clouds, and that process continues to this day, with smaller clumps of normal matter in the shape of dwarf galaxies caught within the dark matter halo and, one by one, falling onto the larger galaxy.

We can see the effects of this in the image of NGC 3521. It has been called the Bubble Galaxy, and for good reason. Trails of stars and gas torn from a dwarf galaxy tortured by NGC 3521's gravity encase it in a shell or bubble of tidal debris. The bubble of debris may have come from an over-sized dwarf – perhaps something twice the mass of the Magellanic Clouds – according to Martinez–Delgado. Circular clouds either side of NGC 3521's disc match features that arise in computer simulations of such a collision. Meanwhile, most notable in GaBany's image are the glowing, fiery clouds in the galaxy's halo.

"I purposefully took very long colour exposures totalling six hours – longer than I have ever devoted to a single image – because I wanted to capture the hues of the outer shell," says GaBany, who used a 0.5-metre telescope from RC Optical Systems, an Apogee Alta U6M CCD and Astrodon filters based at his Blackbird Observatory within the mountains of New Mexico. The bright yellow clouds are thought to be the combined light of older stars ejected from the main spiral disc by the gravitational effects of the merger, while the ruddy dust lanes hide a cacophony of star formation. The flocculent nature of NGC 3521's spiral arms may be a result of this merger, and similar flocculent spirals in the Universe may be evidence of other mergers in the past.

In human times-scales galaxies appear static, but when looked at over hundreds of millions of years they become dynamic and ever-changing, with such activity played testament to by galaxies like NGC 3521.

To see more of Jay GaBany's spectacular imagery, visit his website at www.cosmotography.com, or read about his observatory in our *Gearheads* article in the January 2011 issue of *Astronomy Now*.

■ The Bubble Galaxy NGC 3521 can be seen 35 million light years away at magnitude +11 in Leo. Exposure lengths for this image were 570 minutes luminance, 240minutes red, 240 minutes green and 240 minutes blue. Image: R Jay GaBany.