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BIRTH OF NEW PLANETS

Ken Tapping, 4th November, 2014

A few days ago an amazing image was being passed around the observatory. It showed a bright blob surrounded by concentric fuzzy rings, separated by dark gaps; it looked like a fuzzy archery target. The image was one of the best ever views so far of a planetary system being born. The whole scheme was clearly shown in detail.

Planetary systems – stars with several planets orbiting them (our Solar System is a good example) are formed from collapsing clouds of gas and dust. Since almost every cloud has a little bit of rotation in it, the angular momentum in that rotation is concentrated as the cloud collapses, so that the final result is a rotating disc of material.

As the disc shrinks, dust particles start to collide and stick together. As they get larger the chance they will get hit by other particles increases, and when they get large enough for their gravity to attract more particles and lumps passing nearby, they grow even faster. The newly-forming planet rapidly sweeps up all the material sharing its orbit around the forming star, until there is little material left. The fuzzy rings in that image showed belts of remaining dust; the gaps showed where new planets are growing. Even though they are far too small for us to see, we know they are there because of the cleared-out gaps in the disc.

The image was obtained using ALMA – the Atacama Large Millimetre Array radio telescope, which is a newly-constructed instrument sitting on the high, dry Atacama Plateau in Chile – one of the driest high places on Earth. This instrument consists of 66 “dish” antennas, each 12 metres in diameter. It is one of the most sensitive radio telescopes in the world, and in the wavelength range for which it is designed, it has no rival.

Radio telescopes intended for use at wavelengths longer than a few centimetres, such as our observatory here in the Okanagan, can be at low altitudes, and we make use of valley locations to screen out manmade radio interference. For them, cloud and rain pose no problem when making observations. However, as we choose shorter and shorter radio wavelengths, things get more difficult. Radio waves are just one part of what is known as the electromagnetic spectrum. At shorter wavelengths, below a centimetre or so, the waves start to be less like what we understand as radio and more like infrared. Then cloud and rain become major problems, and even water vapour in a clear atmosphere will absorb the cosmic emissions we are trying to observe. This is a serious problem for millimetre wavelengths.

Unfortunately these wavelengths are astronomically important, because this is where it is easiest to study the dust clouds containing the raw material that gets used to make new stars and planets. ALMA was designed for making such observations – among many other cosmic phenomena, which meant it would have to operate at millimetre wavelengths. To minimize the problems posed by the atmosphere and moisture, it was located at a high, dry place, well above the wet, dense lower atmosphere.

Like most modern astronomy projects, ALMA is an international project, in which Canada is a participant. The development of this instrument led into new areas of technical innovation, in order to develop and build appropriate antennas, radio receivers and signal processing systems. The result is what will be one of the most important astronomical research tools in the world for the next few decades, complementing the Very Large Array and the soon to be built Square Kilometre Array radio telescopes, which work at longer wavelengths. Yes, Canada has a hand in those instruments too. This is an exciting time!

Jupiter rises around midnight. Mars lies low in the sunset glow. Mercury lies very low in the dawn sky. The Moon will be Full on the 6th.

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