RADIO PLANETS

Philippe Zarka – The discovery of exoplanets in the 90's told us only of their existence, their orbit and a little information on their mass but it caused a revolution in the study of the dynamics and in particular of the formation of the solar system. Before, we had just one solar system that required us to explain why rocky planets form near the star, giant planets further away. And we managed fairly well. But the first exoplanets to be discovered were quite unexpected with some of them going around a pulsar and even more strange, hot Jupiters that are big planets that orbit very near their star. And this threw theories of formation up in the air and it was necessary for example to invent planetary migration. In the same way, the magnetospheres of Earth, Mercury, Jupiter, Saturn, Uranus and Neptune are all very, very different judging by what was found by the Voyager probes, even though they are formed by the same universal physical processes. It is therefore all but certain that the discovery of magnetic fields and magnetospheres in exoplanets will lead to a comparable revolution in this topic. The magnetosphere is the gigantic bubble that surrounds a magnetised planet and protects it while at the same time being an accelerator of charged particles. These particles produce auroras and radio waves among other things.

Now the problem is that exoplanets are much further away than Jupiter. Furthermore, the cosmic background that is black at optical wavelengths is very, very bright at radio wavelengths because there are lots of energetic electrons that wander round in the galaxy's magnetic field. The possibility is that detecting exoplanets at radio wavelengths will do much the same as their detection at optical wavelengths where the detection has caused a revolution in the theories of the formation of the solar system. With observations at radio wavelengths we can expect to measure the magnetic field of these planets, their rotation, the inclination of the orbit, the exchange of electromagnetic energy with their star and perhaps the presence of satellites. Note that a magnetic field can be a factor favourable to the formation of life because it in fact protects the surface of the planet and its atmosphere.

Now when we do the calculations we find that antennas with an enormous collection area will be needed if they are to detect radio waves from an exoplanet. Even then, using the biggest instruments available today, emissions will have to be much more intense than those of Jupiter. As for the theory, thanks to more than 25 years of observation with the Nançay decametric network, we were able to respond positively to the question: yes, there are probably radio transmitters much stronger than Jupiter, and probably they are hot Jupiters. As for the astronomical observation, I first used the giant Kharkov radio telescope, in Ukraine, that measures 1 km by 2 km. And thereafter, it was the LOFAR antenna network, a huge latest generation radio telescope, which

stretches more than 2000 km across Europe, albeit with some gaps, of course. A few years ago we joined the engineers and other personnel of the Nançay radio-astronomy in proposing a new telescope called NenuFAR that we are now constructing, the name being an acronym meaning an extension of LOFAR at Nançay. It is an instrument that deploys as many antennas as the whole of LOFAR but the antennas are more sensitive, particularly at low frequencies. They are concentrated in core with a very tight diameter of 400 metres with a few antenna networks stretching out to 3 km and observations will begin in 2018. And then looking into the next decade, there will be the worldwide SKA network that is under study with prototypes being tried now. This will let us detect emissions that are barely more intense than those of Jupiter at distances that include the hundred closest stars, that is to say a few dozen parsecs…

With a bit of luck we will get comprehensive radio-wave observations of the exoplanets and will then have covered the spectrum from end to end. That really would be a very satisfying story, OK not so short because it will have taken twenty five years but when you think about it, that's not much on the scale of the Universe…

03 min 48 sec