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Davos PMOD/WRC instruments flew past Venus this Christmas!

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Just after sunrise, on a clear Davos morning, Venus can be seen brightly shining above Schwarzhorn. It is the second brightest object in the night sky – second only to the Moon. It is beautiful to look at. In December this year, it became special for another reason. Back in February 2020, a new spacecraft was launched from Kennedy Space Center. This European Space Agency (ESA) mission has ten instruments on board – two of which had involvement from PMOD/WRC in Davos. The spacecraft is called Solar Orbiter and will get in close to the Sun, and will be the first spacecraft ever to be able to look at both the north and south poles of the Sun. In June the spacecraft reached nearly halfway to the Sun – the closest that telescopes have ever been. Although the spacecraft will not be in its operational orbit until the end of 2021, we are taking regular 'check-out' data to ensure all is well. Even with this first data, we are already seeing new phenomena that will help us understand the complex and very dynamic changes seen in our star. There are two methods of measurement that are used – to 'see' the Sun through telescopes, and to 'touch' the material from the Sun as it goes past the spacecraft.

Figure 1: A view of Venus rising over Schwarzhorn, December 2020.

Solar Orbiter will make numerous gravity assist flybys of Venus (and one of Earth) over the course of its mission to adjust its orbit, bringing it closer to the Sun and also out of the plane of the Solar System to observe the Sun from progressively higher inclinations. Flybys use the gravity of planets to change the path and speed of a

spacecraft. This will result in our spacecraft being able to take the first ever images of the Sun's polar regions, crucial for understanding how the Sun 'works'. The spacecraft made its closest approach to Venus on the 27th December 13:39 CET reaching a distance of 7,500 km from the surface of the planet. This distance is larger than the radius of Venus. However in later flybys in 2025, the spacecraft will reach just 100 km away from the planet. Some of the 'touching' instruments were switched on during this first Venus flyby, and the data is now being analysed.

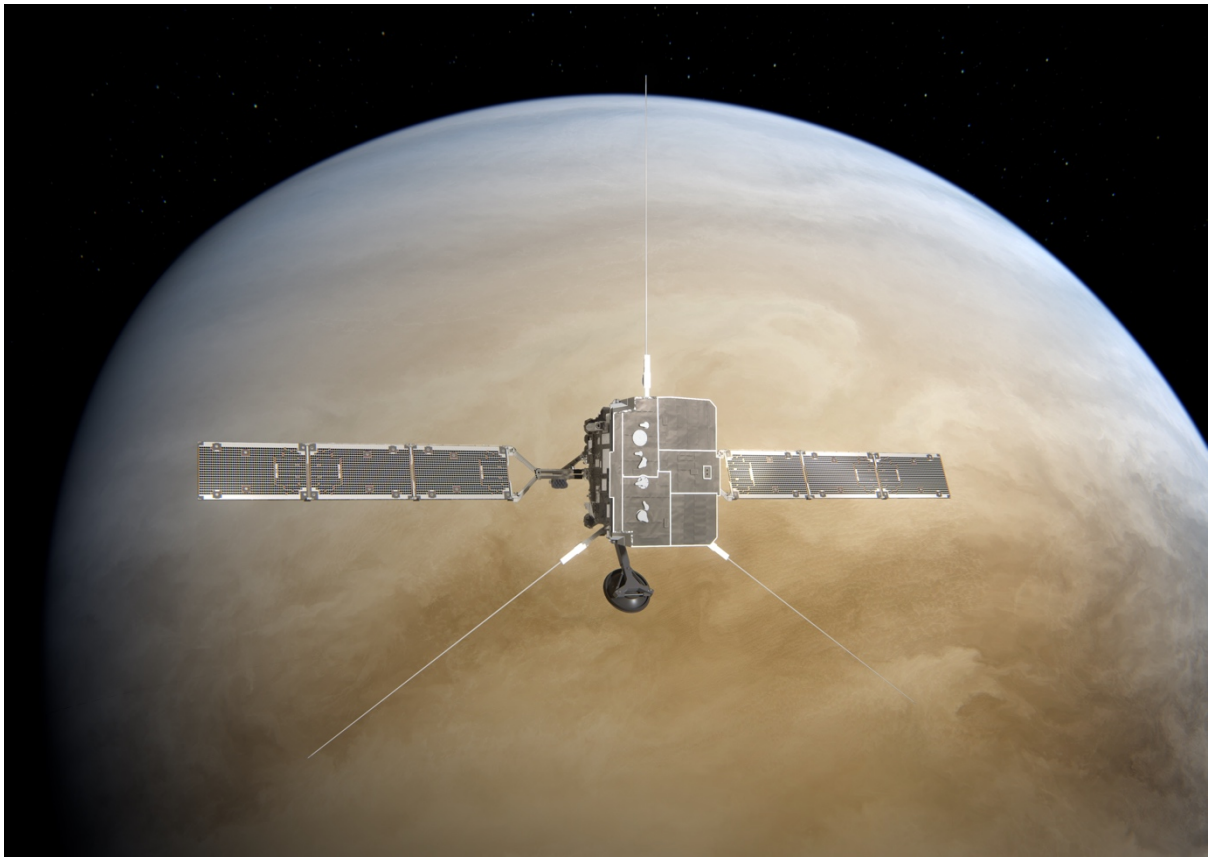

Figure 2: Artist's impression of Solar Orbiter during its flyby of Venus. Courtesy of ESA.

Solar Orbiter is now just at the beginning of its journey. It will continue to use Venus and Earth flybys to get to higher inclinations. Poles of any planets or stars are mysterious, but provide important information on the fundamentals of how they work. The Sun's poles have never before been seen, so this will reveal surprising new results. The mission is planned to operate until 2029, with the clearest view of the poles towards the end of the currently planned lifetime. Space missions like this one, take decades to plan, design, build and test, and this one will operate for ten years. For any schoolchildren interested in a career in space exploration, there are many skill sets required. For the Solar Orbiter spacecraft, many countries around Europe collaborated with colleagues in the US to achieve this. The skill-sets are wide-ranging – from physics, electronics, mechanical engineering, software, orbital dynamics and navigation to name a few. The teams are international, and have, even during the difficult times of the pandemic, continued to operate the spacecraft and all the instruments successfully.

As the spacecraft continues on its journey it will have many ‘friends’ work alongside it. There are many spacecraft and ground-based telescopes that study the Sun that will coordinate actively with us. These facilities are scattered all around the world. A large international community will work together to get the best data. One of these spacecraft is called ‘SOHO’ and was launched 25 years and the instrument built by PMOD/WRC in Davos is still operational. We have already observed a number of solar storms. These solar storms follow an 11 year cycle, and have started to occur more frequently in the past few months, which will provide an exciting time for these spacecraft! This is what we want to understand – why is the Sun so dynamic, why does it produce such energetic explosions (many more time energetic than an atomic bomb), and what is the impact on the technology that we are reliant on here at Earth. Today, another spacecraft is being designed that PMOD/WRC is also involved in. This is a space weather monitor, and will orbit the Sun far from the Earth, at a point in space where it can see if storms on the Sun are directed at Earth. This is to give advance warning of serious storms. It is due to be launched in 2027.