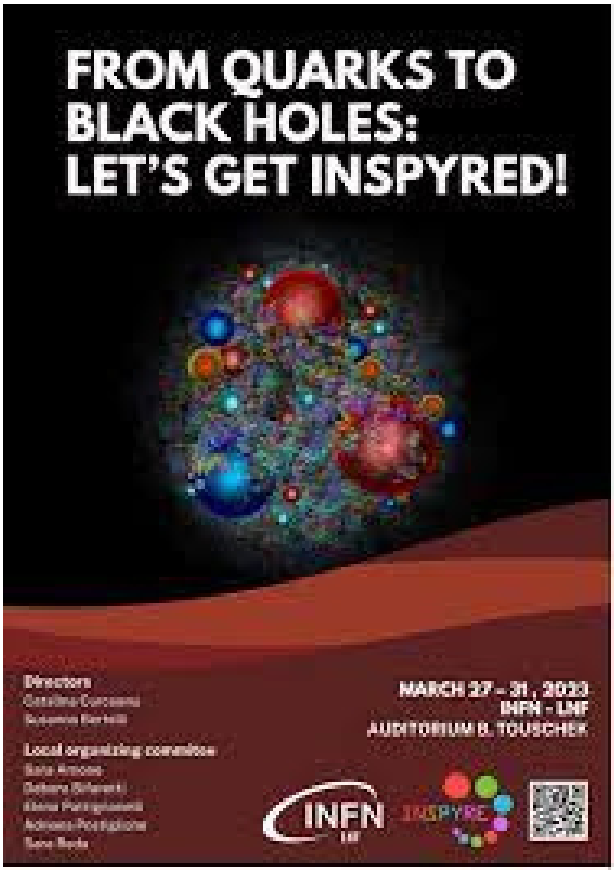
By Marie Maylis, Charpentier Maëlys and Talouarn Lison

For the stage inspyre we went to a University next to Roma in Frascati in Italy. We slept in a hotel located 5 minutes away from the university. On the Monday morning we were welcomed by the INFN (National Institution of Nuclear Physic) and by Catalina Curceanu who is the creator of INSPYRE and most importantly a great romanian physicist and a main researcher at INFN. She works on quantum chromodynamics. INFN, created in 1951, is a research institution with 586 researchers and 144 doctoral students (64 are strangers), the point of that institution, thanks to particle accelerators and many other tools, is medical research and finding the fundamental law of nature. Specifically at LNF (national laboratory of Frascati) is to find the ultimate matter structure, study gravitational waves etc... This edition of INSPYRE (the 13th) is called “from quarks to black holes”, meaning we went from the smallest matter to one of the biggest known. During this week we attended many conferences including one that really impacted us, and that we are going to talk about later. We also visited the Bruno Touschek center. On Wednesday and Thursday morning we did experiments with physicists and other students (we were about 15). We are going to talk about one of the experiments we did.



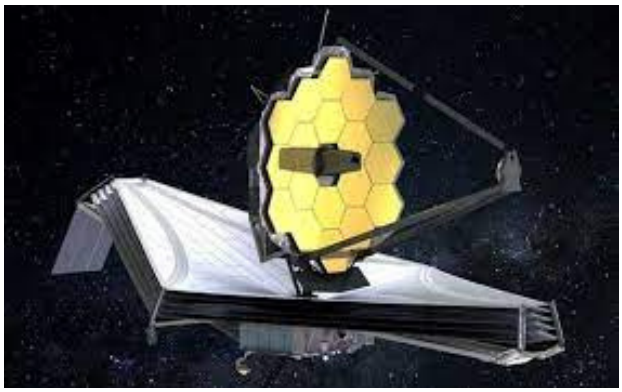
This is what we did during the stage. But we also went to Roma multiple times to visit very big and famous monuments. And during the week we were able to enjoy ourselves by going to the center of Frascati with our teacher’s consent, and we all had fun together, for example with games in the evening.

Example of conference

James Webb Space Telescope : the universe in a sand grain by Fabrizio Vitali

We attended a conference of 1h15 made by Fabrizio Vitali, he explained the advantages of this telescope and how scientists had to find a way to send it to space. The first telescope was made by Galileo in 1609. That's how, thanks to a small telescope, he started to observe things invisible to others. Years later, scientists have realized that we have to use good instruments to observe correctly in a telescope. And then, F.W Herschel discovered infrared radiation and this is when scientists understood that a lot of light was existing in our world and that we had to see all of them to understand life. And it's thanks to infrared radiation that we are able to do it. Before the James Webb Space Telescope there was the Hubble Space Telescope, but it was too imprecise for the researches of scientists who were getting very precise. So they started to think about a successor of that telescope. That's how the James Webb telescope was born. In fact the James Webb is bigger, nicer and with more infrared. He has a 6,6 m mirror so way more bigger than the hubble. But why a bigger telescope ? It's really simple, in fact, for two main reasons : 1° more details and 2° fainter objects.

And why infrared ? 1° To observe observe the most distant galaxies (young universe) 2° To observe stars and planets in formation (cold and dusty objects). But observing in the infrared complicates things a bit : we have to go to space, and because of that : everything has to be cooled. Because even the sun, the earth and the moon can cause irreparable damage to the telescope with their heat. So to find the solution the telescope needs to have two zones : one hot and one cold, really cold (-231°C). But there is another small problem : it does not fit into the rocket. So scientists have imagined how the telescope could enter into the rocket and they found a solution !



The James Webb telescope will close like an umbrella. The telescope was finished on Christmas 2021. Now that the telescope is closed it has to open, and it will take 25 days to open completely once in space. And after that they need to align it. And the results exceeded expectations ! The James Webb telescope could see the warmth of a butterfly at the distance of the moon !! After checking the functionality and calibrate the intruments, the real science part can start : cosmology and structure of the universe, origin and revolution of the first galaxies, birth and formation of stars and planets. And it's on July 12 2022 that we finally had the first image of the James Webb telescope : Galaxy cluster !!

Example of experiment : Nanotechnology for environmental monitoring

There is more and more pollution everyday, so we need to monitor our air to test its quality but for cheap. So in this activity we made an object to monitor the air quality. First, let's remind some basics : the air is composed of 20.9% of dioxygen, 0.9% of argon, 78.1% of nitrogen and the last 2% are different pollutants such as gaseous pollutants but also PM : particle matter. And it is those that we want to measure. They are very small, PM10 : diameter<10 micrometers, PM2.5 : diameter<2.5 micrometers. Those very small particles are very dangerous, they cause many cancers and premature death every year. So we need to monitor them to aware people. There are many ways to detect those particles like a filter (weighting particles) or optical sensors (working with lasers). In this activity we used semi-conductors, physical and chemical reaction and basics electricity laws. The molecules go on a reactive material which changes the resistance of the semi-conductor, leading to a change in the power (P=I*I*R). During the manipulation we used an ADC and a DAC (analog to digital converter and the inverse). We completed an arduino program to use the Joule law (P=I*I*R) and then one of the teachers put the semi-conductor on our microcontroller. When we put our finger on the semi-conductor the curve on the computer would be modified, because the electricity induced by our finger changed the resistance. Then we put the actual sensor on the semi-conductor. To test if it actually worked, we would put a little alcohol pot next to the sensor, the curve on the computer would change because the particles of ethanol would go on the sensor. Theoretically, it works the same with particle matter and with our program that displays the curve P=I*I*R we are able to tell the amount of particle matter in the air. All of that with only a semi-conductor, the Joule law and a little sensor.

Conclusion

During this stage we learnt many things about quantum physic, we met a lot of physicists and foreign students with whom we were able to talk and exchange, for example during the speed-dating or during lunch. This allowed us to be more confident about ourselves. We were able to discover life at the University with conferences, the rhythm of the day. This changes a lot from our highschool students' life that is way more supervised, unlike the university lifestyle that lets us have more freedom but can also be harder, for example by taking notes during conferences and the concentration you need. This experience made us grow and mature. This experience improved our English skills and our physic level as well.