The Planeterrella
A Planeterrella is a set-up that can emulate various astrophysical plasma phenomena like Auroras, it contains two magnetized metal spheres on high (DC) voltage. It is operated in air or other gasses at pressures of about 0.5 mbar. The set-up was built in 2016 and still shows many phenomena which we don’t fully understand.

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Streamers in CO2
The goal is to fundamentally investigate the behaviour of electrical streamers in CO2, generated by high voltage pulses under various conditions. Related applications are high voltage circuit breakers, understanding lightning strike observations on Venus and solar fuels utilizing CO2 conversion. Experimental measurements will mostly consist of high speed imaging, where we use advanced techniques to try and derive the streamer characteristics.

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Comparison of discharge inception in the Venus (CO2) and the Earth (Air)
Lightning can happen in Venus like Earth. Because of different gas composition in Venus (CO2) and Earth (N2 and O2) composition, they have shown different electric discharge characteristics. Here, we aim to understand the difference of lightning inception in the atmosphere of Earth and Venus. We can produce discharge in different gases in the lab. Because of difference in the chemical and physical properties of gases, we observed different voltage breakdown and inception physics. Thus, our goal is to find the physics of lightning inception in CO2 and Air, by measuring the discharge inception properties under different conditions.

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The Mystery of Lightning Inception
Perhaps one of the most enigmatic questions about lightning is the issue of how lightning is initiated inside thunderstorms; while the observed electric fields are of an order of magnitude less than that required for air breakdown. One solution that has been developed during recent years is the lightning inception from hydrometeros. Here we aimed to figure out the properties of electric discharge inception from hydrometeros in the lab under different conditions in order to understand more in the physics of lightning initiation.

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Vibrational ladder climbing parameter scan (in DIFFER)
The decomposition of CO2 to CO is crucial in the production of CO2 neutral solar fuels. In the past, 90% energy efficiencies were obtained in CO2 plasmas explained by the vibrational ladder climbing mechanism. We have provided the first experimental proof of this mechanism by exciting CO2 gas using a MIR laser. The aim of the project is to make a parameter scan and to find optimal experimental conditions for vibrational ladder climbing varying the excitation conditions, temperature and pressure of the gas, and/or studying the effects of impurities.

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Plasma-catalysis as vibrational activation of surface reactions (in DIFFER)
Several studies have shown synergistic effects when combining plasma with a catalyst resulting in a higher conversion and selectivity. For this reason, plasma-catalysis is a promising method to conduct endothermic reactions under milder conditions. However, fundamental understanding of plasma-activated species with surfaces is absent. In our clean experiment, a MIR laser is used to study vibrationally excited species interacting with a catalytic surface excluding the effects of other components of the plasma, e.g. ions, electrons and radicals.

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The road to a quantum dot-based plasma diagnostics technique
Semiconductor quantum dots (QDs) continue to attract enormous interest for their applications in optoelectronics and light emitting devices. In this project we mainly focus on the understanding plasma charging by using photoluminescence (PL) properties of QDs. The proposed experiments merge three fascinating processes: controlled injection of colloidal CdSe/ZnS QDs inside the low pressure RF plasma, the ability of plasma discharge to charge and confine nanoparticles, and monitoring the surface charge-induced shift in PL spectrum of QDs in the plasma. This time-resolved PL shift of QDs will be utilized to probe the different processes behind plasma-particles interaction for the first time ever!

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Investigating negative ions in oxygen RF plasma with laser-induced photodetachment

Electronegative plasmas consist of negative ions as well as electrons, positive ions and neutrals. One approach to probe the dynamic of negative ions is to convert them into electrons and neutrals then subsequently detect detached electron. This process is known as laser-induced photodetachment. In this project both laser-induced photodetachment and Microwave Cavity Resonance Spectroscopy are utilized to probe the dynamic of negative ions in different states of oxygen RF-CCP plasma, most particularly in the afterglow of pulsed plasma.

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Washing the atmosphere

Radioactive materials in the atmosphere come from many natural sources: processes deep in the soil and those stemming from cosmic radiations. Soil processes are disintegration of uranium and heavier nuclei leading to escape of the noble gas radon with in its turn leads to radioactive daughters such as 214Bi and 214Pb. These isotopes have half-lives of the order of half an hour.

Cosmic rays are extremely energetic particles that produce many nuclear reactions in the atmosphere, mostly leading to fast gammas and muon, as well as a small portion of lighter nuclei. Detectors for gammas and muons are installed at four positions on TU/e, as our contribution to the project Hisparc (www.hisparc.nl). Registration occurs 24/7, and the data are transmitted to NIKHEF (www.nikhef.nl). Also several schools participate in the project. The data on the NIKHEF servers are openly available for further evaluation by students and pupils.

The average detection rate per Hisparc station is about 1 event per 3 seconds. However, during intense rainfall this increases substantially, with peaks up to seven-fold in a period of up to half an hour. Various explications have been proposed: density variations caused by gravity waves in the atmosphere (like the oil/water interface in lava lamps), increased scattering density due the rain drops, increased density near the soil due to the Bi and Pb isotopes brought downwards by the rain (washing effect). But we do not know what kind of process is most important.

We therefore propose to measure the radioactivity near a Hisparc station, together with the coincidences and the weather parameters such as temperature, pressure, rain fall. In the project the detector for radioactivity must be designed and built. Some components are already present, such as a suitable scintillation detector with its power supply for the gammas from the Bi and Pb isotopes. For the determination of the gamma spectrum one needs a multichannel analyzer and a small PC for data storage. The student could then focus on these items, the local registration and transfer of the data to NIKHEF. Assistance from NIKHEF when needed is guaranteed.

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Plasma assisted combustion

Plasma-assisted combustion is a promising method to enhance flame-stability in low-temperature flames. The reduction of flame temperature is important for reducing NOx emissions. However, control over the combustion process via the creation of radicals using plasma is not well understood. The goal is to gain an understanding of the plasma activation of combustion via experimental works. This project provides an opportunity to play with cool stuffs like plasma, flame, vacuum, laser and optics. A new experimental setup aiming at low-temperature combustion activation studies for various plasma parameters has been developed. Experimental work will mostly include high speed imaging, Optical emission spectroscopy and electrical characterization.

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Direct electric field measurements on plasmas

The electric field is the driving force behind every plasma. Currently used techniques to measure this electric field are invasive, cannot be applied to a broad range of plasmas or are limited by photon emission. A new technique to measure electric fields in plasmas, called E-FISH (Electric Field Induced Second Harmonic generation), overcomes these disadvantages. A laser beam interacts with the electric field and thereby the frequency is doubled. The amount of light with double the frequency scales with the electric field. The goal of this project is to provide a theoretical description of this new technique regarding beam properties and thereby assess the validity of the used assumptions.

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En meer!
Staat je favoriete plasmaonderwerp hier niet tussen of heb je zelf ideeën voor een onderzoek? Laat het ons weten! In overleg kunnen we een project op maat maken zodat het helemaal aansluit bij jouw wensen.