Abstract

A "planeterrella"-type plasma discharge chamber has been constructed at the UAA Plasma Lab for student research projects and educational use. The device comprises an 18-inch diameter by 18-inch high Pyrex cylinder with aluminum end plates, with dry mechanical pumping to 50 mTorr. Argon and air can be admitted, with typical operating pressure 0.1 - 2.0 Torr. Two aluminum spherical electrodes with embedded permanent magnets act as anode and cathode for the DC glow discharge regime (e.g. 500 V, 10 mA), which can simulate aspects of planetary aurorae. Diagnostics are being added to the device, such as a Langmuir probe, UV-Visible spectrometer, and high speed camera, and integration of these with the discharge control software is presented along with time resolved measurements of the plasma environment.

Planeterrella:

Planeterrella was designed by Dr. Jean Lilensten at the Institut de Planetologie et d' Astrophysique de Grenoble (1). The Plasma Physics Lab at UAA was allowed to use the design, and make functional modifications to better suit diagnostic equipment. As mentioned, it is a glow discharge plasma source, using two spherical, embedded-magnet electrodes and one needle electrode to produce plasma. There is a voltage controlled piezo-electric gas inlet that can either allow air or argon in order to control pressure and change the dynamics and emission spectra. A convection gauge is used to monitor pressure in the chamber, and can output to a control system. The device is mounted in a mobile rack for transport to classrooms and demonstrations.

Apparatus:

Planeterrella is an excellent demonstration device, but would benefit from greater ability to make quantitative measurements. In addition, the device settings are not easily adjusted, as it must be opened to move electrodes. This is unfortunate, as the device displays numerous phenomena that can currently only be seen with the naked eye. Below is an example of a typical magenta discharge from the larger electrode.

Mechanical Improvements:

• A custom ISO160-K feedthrough flange for the diagnostic equipment is under construction
• New Teflon electrode arms with extra-vacuum access and two degrees of freedom (axial and vertical) is being built for each electrode.

Diagnostic Improvements:

• Langmuir probe parts are being ordered and will be assembled.
• National Instruments I/O modules will allow LabVIEW access to the system for control and recording.
• A high-speed camera (Kron Chronos 1.4) and Kodial glass viewport have been acquired.
• A UV/Visible (200-900 nm) Ocean Optics HDX spectrometer has been purchased and will be mounted to the chamber.

Diagnostic Equipment and Upgrades:

A probe has been designed and modeled extensively. The alumina insulator has four bores so it can later be upgraded from a single probe if needed. KF16 feedthrough flanges will be used for connections. In addition, a compression coupling allows the probe to be shifted vertically. With this probe, data on plasma density, temperature, and potential will be gathered through LabVIEW analysis (2).

LabVIEW and Control Systems:

Through the use of National Instruments I/O modules, control systems will be implemented to allow for automated pressure regulation, electrode voltage settings, and possibly electrode arm positioning in the near future. With new diagnostics, along with existing systems (a voltage controlled gas feed and pressure sensor) these types of control systems will be easily constructed. This will be invaluable for the understanding and study of the many modes that Planeterrella exhibits. Aside from this, automation would allow for easy demonstrations, increasing interest in plasma physics.

Diagnostic Improvements:

• A UV/Visible Ocean Optics HDX spectrometer, and high speed camera, and integration of these with the discharge control software is presented along with time resolved measurements of the plasma environment.

High Speed Camera:

A new Kron Chronos 1.4 high speed camera was purchased recently, able to capture 1.3 megapixel 1280x1024 images at 1057 fps or up to 38,500 fps at reduced quality. and when placed in tandem with the Kodial glass viewport it will allow for a more rigorous study of the time dependent properties of plasma discharges in this device.

As mentioned, Planeterrella has many different characteristics that vary greatly with even slight setting and environment changes. Some of the most interesting dynamics are striations (both static and slowly time-variant), ring currents, arcing/ strobing discharge, and slow time-dependent discharges (rotating, fluctuating brightness, etc.). However, these properties were only observed qualitatively, so diagnostics like a high speed camera would likely reveal many more dynamics and deepen our understanding of each phenomenon.