P10

Near Infrared Photo-absorption in Plasmas for Astrophysical Applications

Kirsten Dowd, Tom McCormack and Padraig Dunne

University College Dublin
kirsten.dowd@ucdconnect.ie

Keywords: NIR Absorption Spectroscopy, Laser Produced Plasma, Kilonova, AT2017gfo

This poster discusses the experimental design and results of the first iteration of near infrared (NIR) photo-absorption experiment. Half of the elements with Z > 26 are believed to be synthesised via rapid neutron capture (r-process) in binary neutron star (BNS) mergers, due to their neutron rich and explosive environmental conditions [1]. Electromagnetic radiation is thermally emitted from the neutron rich ejecta of these events is mainly emitted in the ultraviolet (UV), optical and infrared spectral regions [2][3]. The first detection of such a kilonova event occurred in August 2017. Photometric and spectroscopic follow up observations were carried out to observe the evolution of this event. To accurately model merger events and identify elements synthesised in the AT2017gfo kilonova spectra, precise experimental values of wavelengths, oscillator strengths and atomic cross sections for absorption lines present in a wide range of heavy elements are required. Currently, a set of complete atomic data for elements present in the visible and NIR spectra of AT2017gfo, and those theorised to be formed in BNS mergers does not exist [4].

This project aims to develop a new NIR photo-absorption experiment using laser produced plasmas (LPP) to obtain a more complete set of experimentally found NIR atomic line lists. The experimental set up currently consists of a tuneable, broadband optical parametric oscillator (OPO), a neodymium-doped yttrium aluminium garnet (Nd: YAG) and an Acton SpectraPro 2750 Czerny-Turner Spectrometer. The ND: YAG laser acts as the pump, generating the absorbing plasma while the OPO is used as the continuum source probe. The experimental setup is shown in Figure 1. The Nd: YAG is fired first and is incident on a metal target, generating a LPP. The OPO laser is fired after a set time delay, Δt, and is absorbed by the target plasma. The I and I_0 laser beams are incident on different regions of the spectrometer slit. The time delay is varied in order to probe different ion stages present in the plasma. Using this experimental set up, absorption lines of four elements have been found, yttrium, zirconium, niobium and vanadium, in narrow bands of the NIR between 870 and 930 nm.

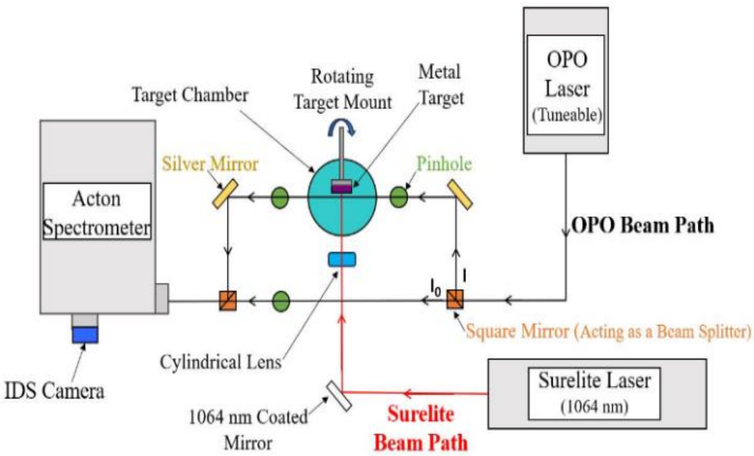

Fig 1: Diagram showing the NIR photo-absorption experimental apparatus.

References

[1] Watson et al., *Nature*, *574*(7779), pp.497-500 (2019).

[2] Smartt et al., *Nature*, *551*(7678), pp.75-79 (2017).

[3] Kasen at al., *Nature*, *551*(7678), pp.80-84 (2017).

[4] Gillanders et al. 2021.*Monthly Notices of the Royal Astronomical Society*, *506*(3), pp.3560-3577 (2021).