
**Research Networking Programmes**

# Exchange Visit Proposal – Report

**Application (one single document in WORD or PDF file) should be submitted online at least two months in advance of the event.**

***Proposal Title**: The study of the optical properties of water compressed at pressures of several Megabar by laser-driven shock waves.*

## 1) Purpose of the visit

The behavior of water at very high pressures has been the subject of several recent works. The interest is largely justified by planetological research. Together with ammonia and methane, water is one of the main elements of the mantles of giant planets like Uranus and Neptune. The observation of a large and asymmetric magnetic field in those planets has prompted the idea that the field is originated in the mantle. Since the dynamo effect requires the presence of a conductive material, a phase transition to the metallic state has been suggested. Such phase transition has been evidenced in molecular dynamics simulations. At lower pressure, an interesting super-ionic phase of water has also been predicted.
The goal of the work was to analyze the data collected at pressure below metallization of the water falling into two regimes:
a) at low pressure,
b) at higher pressure.

### Description of the work carried out during the visit

During the visit I took part in analysis of an experiment performed by the group of Prof. D.Batani on the behavior of water compressed at pressures of several Megabar by laser-driven shock waves. In the experiment a high-energy laser beam was focused on an Al foil sealing a water sample. The shock was generated in aluminum and later transmitted to water. Experimental data were collected at RAL, using the laser Vulcan, and at LULI, using the laser LULI2000.
The diagnostics used in the experiments included:

- shock chronometry to measure the breakout of the shock at the Al/Water interface
- SOP (streaked optical pyrometry) to measure the temperature of the shocked sample

VISAR (velocity interferometer) allowed measuring the velocity of the Al reflecting surface or, when water metallizes, the velocity of the shock front in water. VISAR also allowed measuring the reflectivity of the sample.

I have analyzed the data collected at pressure below metallization falling into two regimes:
**a)** at low pressure - water remained transparent.
**b)** at higher pressure - water became opaque.

## 2) Description of the main results obtained

I have analyzed the data collected at pressure below metallization falling into two regimes:
**a)** at low pressure - water remained transparent. VISAR fringes were clearly visible and allowed measuring the velocity of the Al and water interface;
**b)** at higher pressure - water became opaque and absorbed the probe laser bean used for VISAR. In this case the fringes quickly disappeared.
In both regimes the VISAR saw the reflection from the aluminum surface through the water sample. This allowed retrieving the value of the refractive index of water, its real and imaginary part.

## 3) Future collaboration with host institution (if applicable)

The visit will start long-term collaboration including also common experiments.

## 4) Projected publications / articles resulting or to result from the grant (ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)

Results will be compared to various existing theoretical predictions present in the scientific literature obtained using molecule-dynamics simulations or other types of theoretical approaches. Future collaboration in experiments devoted to water properties are foreseen.

## 5) Other comments (if any)