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WATER IN ASTRONOMY AND PLASMA PHYSICS AND A PROJECT FOR RELATED RESEARCH

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Abstract. Importance of the investigations of water in astronomy, water-plasma interaction and discharges in water for the removal of organic pollutants and microorganisms from water, as well as the significance of discharges in water for medicine are briefly reviewed. It is also announced and briefly discussed our project for investigations of plasma-water interaction, plasma containing water molecules, or obtained in the presence of water molecules, of interest for astronomy, laboratory physics and technology.

1. WATER IN ASTRONOMY

The importance of water, the dissolvent without whom our kind of life would be impossible, is obvious and the research of all aspect of this compound is of great interest for many sciences. In astronomy, water is found in comets, Jovian satellites, on the Mars... The first molecule to be detected by radio astronomy methods, was the radical OH in 1963. Some OH sources in interstellar H II regions show strong H_2O emission as well. Their H_2O emission is variable, with intensity changes occuring in periods of months and days. In such regions temperature is around 10000 K and ion density around 5000 ions on m^3. Water molecules are found and in OH-IR stars, which are probably dust enshrouded Myras having period 600 - 2000 days, and are not visible optically. Recently, water molecules have been detected in the mid-infrared (11-12 microns) spectrum of Arcturus, a K1.5III giant star (Ryde, N., et al. 2003). In Brand et al. (2003) analysis of the properties of water maser emission in 14 star forming regions has been performed while Beck et al. (2003) have found and investigated water vapor emission from an elliptical ring of masers located near the protostar Cepheus A HW2.

2. PLASMA-WATER INTERACTION FOR WATER TREATMENT AND SOME APPLICATIONS IN MEDICINE

Plasma obtained from H_2O is of interest and for investigations of underwater discharges, some aspects of electrolysis research, and for various treatments of water. Namely, electrical discharges in water or close to water as pulsed corona discharge, electric barrier discharge and contact glow discharge electrolysis techniques are used e.g. for decomposition of organic pollutants (Sun et al, 1997, Joshi et al, 1995, Hoeben et al, 1999, Šunka et al, 1999, 2004, Arif Malik and Ghaffar, 2001, Sano et al. 2003, Šunka et al, 2004) and for the removal of microorganisms from water (Sun et al, 1999). Such investigations are of particular interest since there is a continuing need for the development of effective, cheap and environmentally friendly processes for the disinfection and degradation of such pollutants in water. An overview of such techniques and important developments that have taken place in this area are discussed in Arif Malik and Ghaffar (2001) and Šunka et al. (2004). In Serbia, coaxial dielectric barier discharge for potable and waste water treatment is studied in detail by Kuraica et al. (2004ab), which developed also an ozonized water reactor system. Sano et al. (2003) developed a cylindrical wetted-wall corona-discharge water purification reactor, which was used for the study of decomposition of phenol in water by corona discharge.

Laser induced breakdown plasma in water is of interest for pulsed cellar microsurgery and micromanipulation and microirradiation techniques. In Venugoplan et al. (2002) for example, the physical processes underlying pulsed cellular microsurgery and micromanipulation have been investigated using nanosecond 532 and 1064 nm laser pulses. Moreover, the implications of obtained results for biophysical microirradiation procedures are discussed. Underwater spark discharges are also of interest for the development of the so-called extra-corporeal shock wave lithotripsy, a noninvasive method for treatment of kidney stone desease (Burlion et al. (1994). Namely we have spark discharge between needle electrodes in water, providing a point-like source of strong shock waves. When the discharge is in the focus of a semi-ellipsoidal metallic cavity, the wave energy is concentrated in the secondary focus. If the kidney stones is positioned in the secondary focus the interaction with the shock wave results in crushing the stone into small particles that naturally leave the body (Šunka et al. 2004). The success of this method stimulated also the study of the focused shock waves applications in other branches of medecine (Coleman and Sounders, 1993).

3. PLANS

We are beginning our research work concerning plasma generation in water. Investigations will be undertaken from aspects of laboratory, technological and astrophysical plasmas, experimentally and theoretically. We have started to construct two devices with corona discharge, one reactor with wire cathodes out of water and plate anode submerged in water. A gas corona discharge is directly contacted with a treated water surface. The second one is a wetted-wall corona-discharge reactor. Our first task will be directed to investigations of plasma-water interactions and plasma induced water characteristics (disinfection and degradation of organic pollutants in water). We are

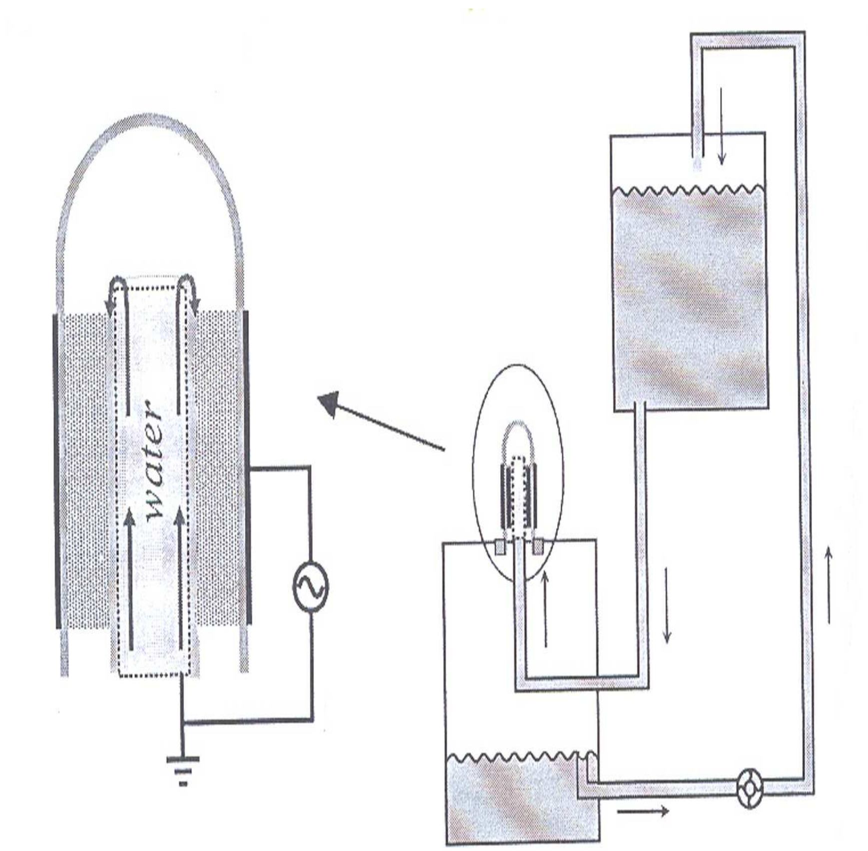

Figure 1: (From Kuraica et al, 2004a.) Schematic diagram of the ozonized water reaction system. Water flows up through a vertical hollow cylindrical electrode and flows down making thin dielectric film over the electrode. Filamentary discharge is generated in air within 4 mm gap between the dielectric and the water layer.

ready for collaboration with similar groups working in this domain in Bulgaria and Serbia.

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