

## Nevada Astrophysics

### Introduction

We have assembled a team of Astrophysicists and Atomic Physicists from University of Nevada, Las Vegas (UNLV) and University of Nevada, Reno (UNR) to conduct research in theoretical and laboratory astrophysics relevant to NASA's mission. The team includes: Bing Zhang, high energy astrophysics with an emphasis on Gamma-Ray Bursts; Daniel Proga, high energy astrophysics, particularly problems involving magneto-hydrodynamics; Kentaro Nagamine, cosmologist working on structure formation in the universe; Bernard Zygelman, atomic physics with expertise in heavy particle collisions; Balakrishnan Naduvalath, molecular physics working on molecular collision theory; Victor Kwong, atomic physics experimentalist with expertise in charge transfer reactions; Stephen Lepp, astrophysicist, particularly astrophysical models involving atomic and molecular physics; Andrei Derevianko, atomic physics with experience in many body methods and high precision calculations; Roberto Mancini, atomic physics, particularly models of plasmas and Ronald Phaneuf, atomic experimentalist specializing on photoionization in high temperature plasmas. We intend to use this team to make a joint comprehensive effort at solving problems of interest to NASA.

With this team we can tackle a wide range of problems of interest to NASA. Gamma ray bursts are the most energetic and luminous explosions in the universe. Marking the births of black holes, these events involve most extreme physical conditions in the universe, and serve as an ideal laboratory to explore frontiers of physics and astrophysics. Bing Zhang proposes a multi-dimensional study of GRBs, which includes analytic and numerical theoretical modeling, detailed data reduction and statistical analysis, as well as broad-band observations. Daniel Proga will work on accretion processes onto compact objects, related mass outflows, and their environmental impact on the galactic, intergalactic, and cosmological scales. Both of these involve high temperature plasmas and so will benefit directly from collaborations with Ronald Phaneuf and Roberto Mancini. These high energy events can also be studied by their impact on nearby interstellar gas. To model these regions requires new atomic and molecular data. Bernard Zygelman proposes to calculate proton impact cross-section data and develop a general-purpose code for use by NASA researchers. Balakrishnan Naduvalath will undertake detailed calculations of H<sub>2</sub>-H<sub>2</sub> collisions using quantum mechanical scattering calculations on accurate molecular potentials. Stephen Lepp will develop models of x-ray illuminated regions using this data. Andrei Derevianko will perform high precision atomic calculations on isotopes to further understand the observational evidence for a shift in fine structure constant, which have been observed in spectra of quasars. Proga studies the accretion process onto the central black hole harbored by quasars, and the energetic feedback from black holes have significant effects on galaxy formation process that Nagamine studies. Victor Kwong will pursue laboratory work on charge transfer cross sections.