Notice of the Final Oral Examination
for the Degree of Master of Science

of

SKYLER WHEATON

BSc (University of Washington, 2012)

“Optical Trapping and Inspection of Nanoparticles with Double-Nanohole Optical Traps”

Department of Physics and Astronomy

Wednesday April 22, 2015
1:00 P.M.
Elliott Building
Room 161

Supervisory Committee:
Dr. Reuven Gordon, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. Geoffery Steeves, Department of Physics and Astronomy, UVic (Member)

External Examiner:
Dr. Stephanie Willerth, Department of Mechanical Engineering, UVic

Chair of Oral Examination:
Dr. John Walsh, Department of Education, Psychology and Leadership Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

This thesis presents the optical trapping of various nanometric particles both biological and non-biological and methods that can be used to extract information about the trapped particle from the signal transmitted through a nanoaperture trap. These methods are used to detect the excitation of vibrational modes in trapped particles due to the presence of a beat signal between two tunable trapping lasers and the molecular weight of the particle by examining the transmitted signal. Optical trapping has long been used to trap ever smaller particles in gentle non-destructive ways. In its infancy only the optical trapping of micron sized particles was feasible. Due to various limitations, changes to the optical trapping scheme were needed to push its limits into the nanometric regime. Nanoaperture assisted optical trapping has allowed for the optical trapping of particles as small as 5 nm in diameter. By making use of specially chosen nanoapertures in gold films higher trapping strengths with lower incident laser powers have become possible. While this is an accomplishment in and of itself there are several issues associated with working with such small systems. Most notably, the ability to observe such systems is very limited. Traditional optical trapping of micron sized particles could make easy use of optical inspection, however in the nanometric regime this is not possible. It has since become a focus of the trapping community to find sophisticated ways to use the limited data available to probe these systems and their trapped targets. Once a particle is trapped the only information available about the particle is contained in the signal transmitted through the nanoaperture. The first main area of research in this thesis covers using this information to extract the molecular weight of the trapped particles for identification. In the same vein, Raman has been a tool widely used in the past to identify and probe systems of large ensembles of particles. While this is incredibly effective in some situations, it is not effective at the single particle limit. To form an analog that can be used within an optical trapping setup a new method of exciting Raman active vibrational modes with twin trapping lasers is presented. The low wavenumber vibrational spectra are presented for several different particles as well as a wide array of globular proteins.