

Predicting the NEO harvest of the BlackGEM array



Bachelor research supervisors: Kateryna Frantseva and Gijs Verdoes Kleijn

Jasper Postema

BSC student, Kapteyn Astronomical institute,
University of Groningen

My Bachelor Research Project

The aim of my Bachelor research project was to predict the detectable population of Near-Earth Objects (NEOs) with the new BlackGEM Telescope Array. I developed software that simulates the survey operations and sensitivity for NEO detections. I also simulated NEO ephemerides using services provided by the IMCCE (SkyBot) and the Minor Planet Center. The simulation predicts that the BlackGEM SASS survey can detect 4244 previously unknown NEOs. Most have a diameter ~ 200 m, the size range of a high fraction of unknown Potentially Hazardous Objects.

The Minor Planet Center

The Minor Planet Center, MPC, keeps a list of all known asteroids and comets and some of their properties. These include: semi-major axis, eccentricity, absolute magnitude and many other useful properties. These properties are all related to the name of the minor body. The distributions of some of the orbital parameters of the detected NEOs are plotted in figure 4. The distributions of the same orbital parameters of all NEOs are also shown. Since the distributions are similar I concluded that BlackGEM has no bias in detecting NEOs.

Discovering NEOs

The final goal of my thesis was to predict how many new NEOs can be discovered using BlackGEM. This was done by multiplying the detection fraction in figure 5 by the fraction of undiscovered NEOs from Harris and D'Abramo (2015) in figure 4. The amount of newly discovered NEOs as a function of their diameter is shown in figure 6. Summing over all diameters gives a total of about 4000 new NEOs that will be discovered by BlackGEM.

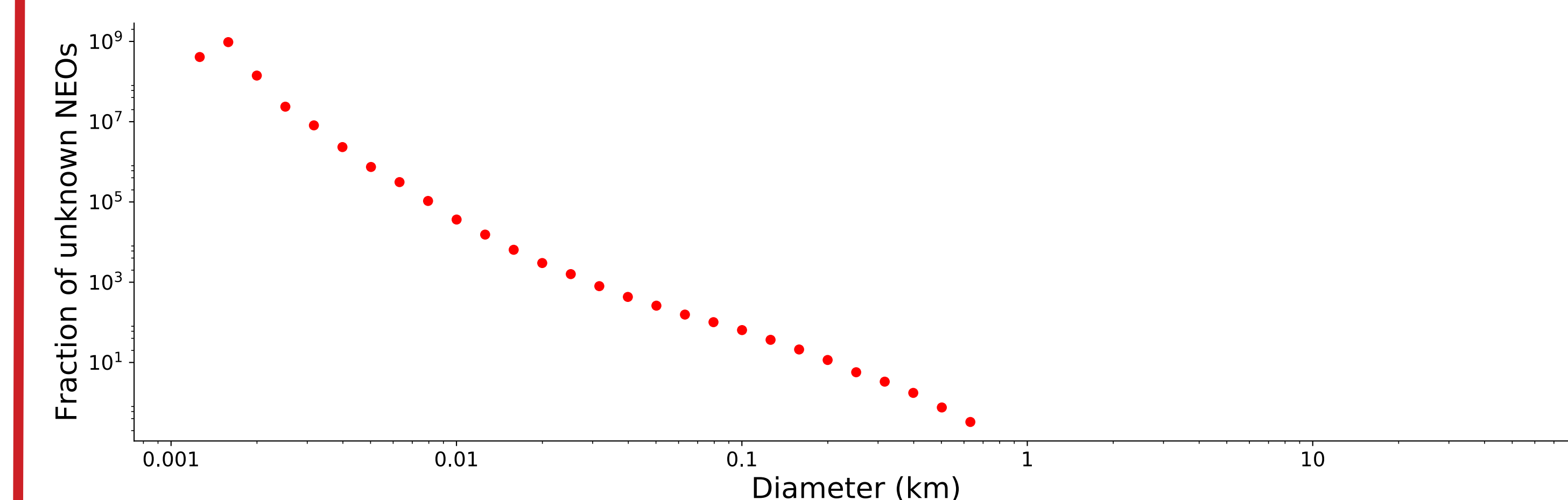


Figure 5: Fraction of undiscovered NEOs as a function of NEO diameter

The BlackGEM Telescope Array

The BlackGEM telescope array is currently being installed at the ESO site in La Silla, Chile and its main objective is to detect the optical counterpart of gravitational waves. During its surveys it will also be able to detect NEOs. One of the BlackGEM telescopes is shown in figure 1.

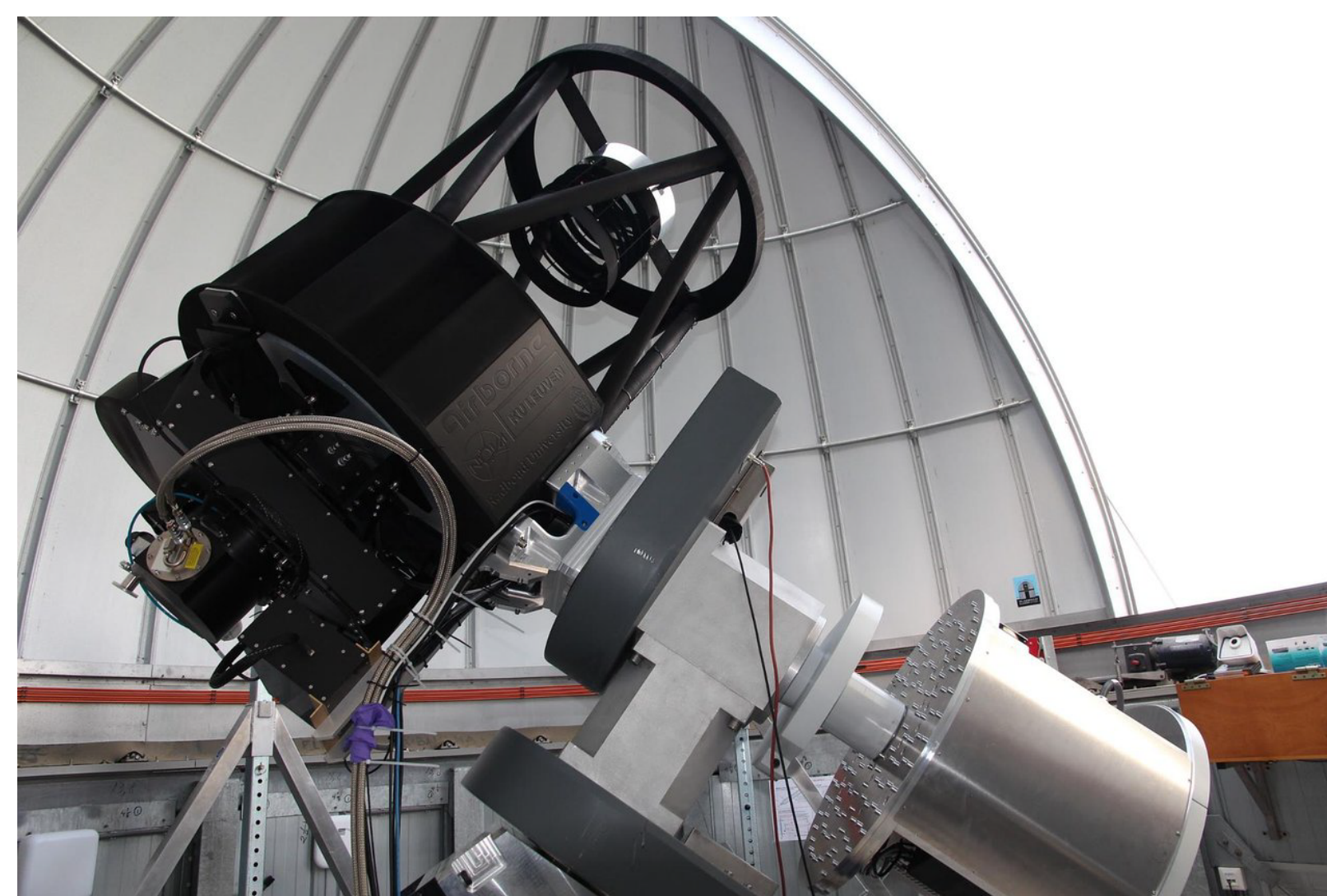


Figure 1: One of the BlackGEM telescopes

SkyBot

The web service of the Sky Body Tracker project, SkyBot was made with the intention to provide astronomers with a tool to determine the detections of known Solar System objects in an image. SkyBot has a database containing the pre-computed ephemerides of all known Solar System objects.

The Pipeline

During my thesis I determined which known NEOs were in the fields during the survey. SkyBot can tell which NEOs are in view for a given sky location and time. Skybot provides the NEO properties required to determine detectability by BlackGEM. The result is shown in figure 4. If more properties, like orbital parameters are needed, the MPC can also be used it. Because the MPC and SkyBot use the same NEO names, properties from the MPC can easily be related to the NEOs in the fields. The final pipeline used in the simulation is shown in figure 2.

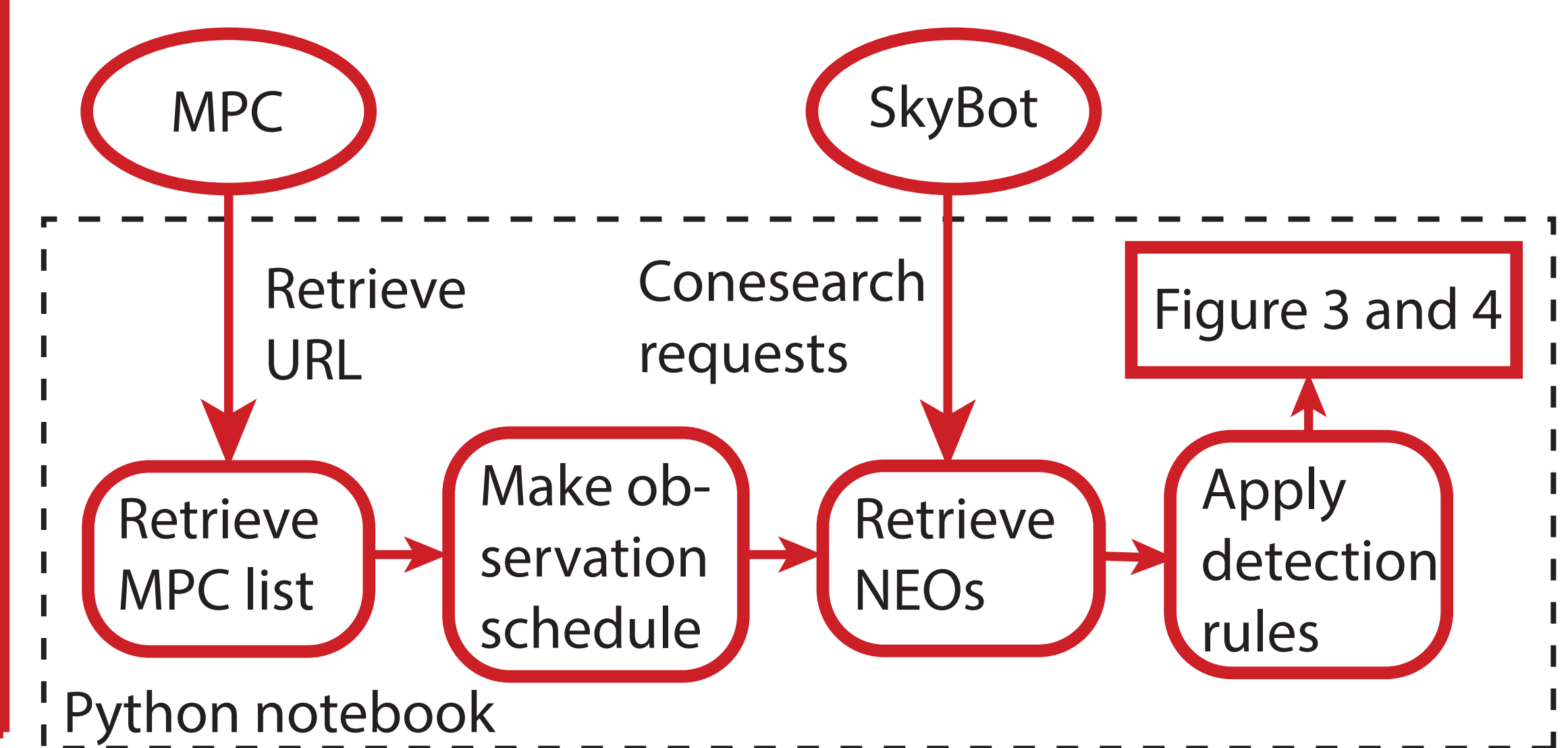


Figure 2: The pipeline incorporating the MPC database and SkyBot used in the simulation

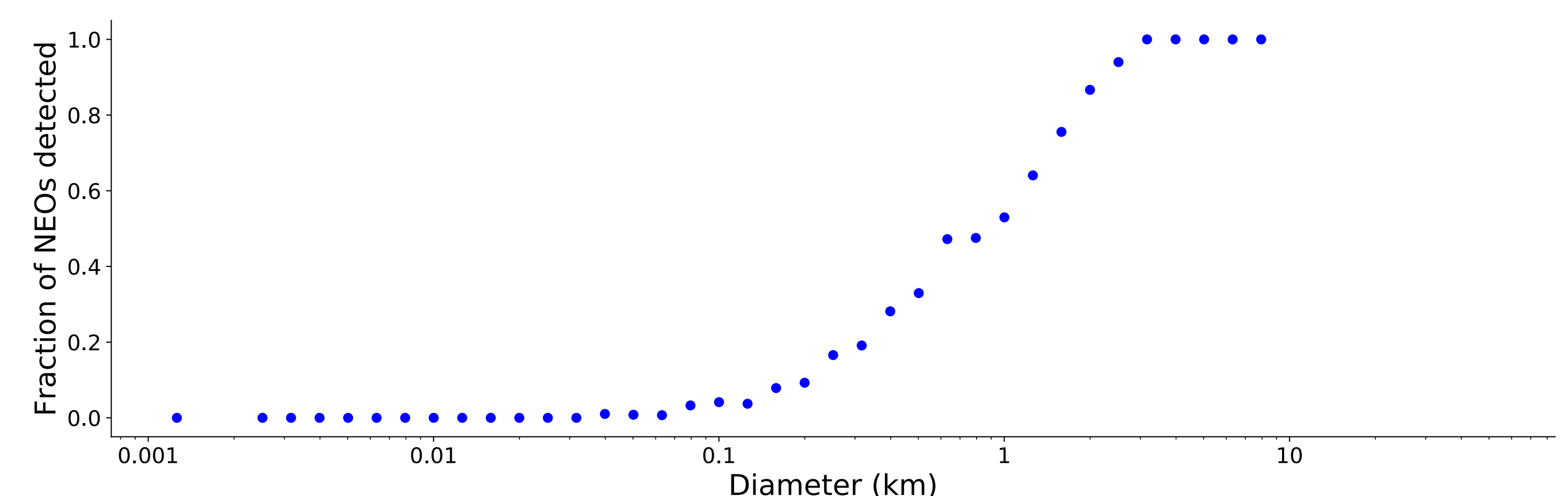


Figure 3: NEO Detection fraction of BlackGEM as a function of NEO diameter

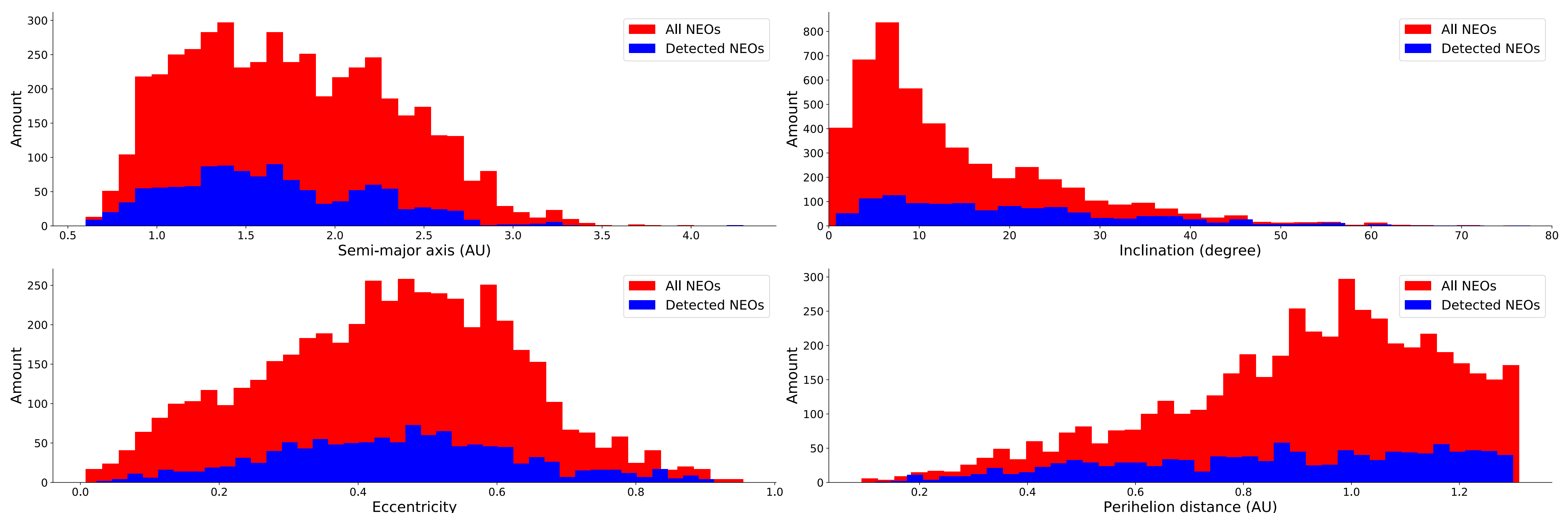


Figure 4: Histograms of orbital parameters of all and detected NEOs

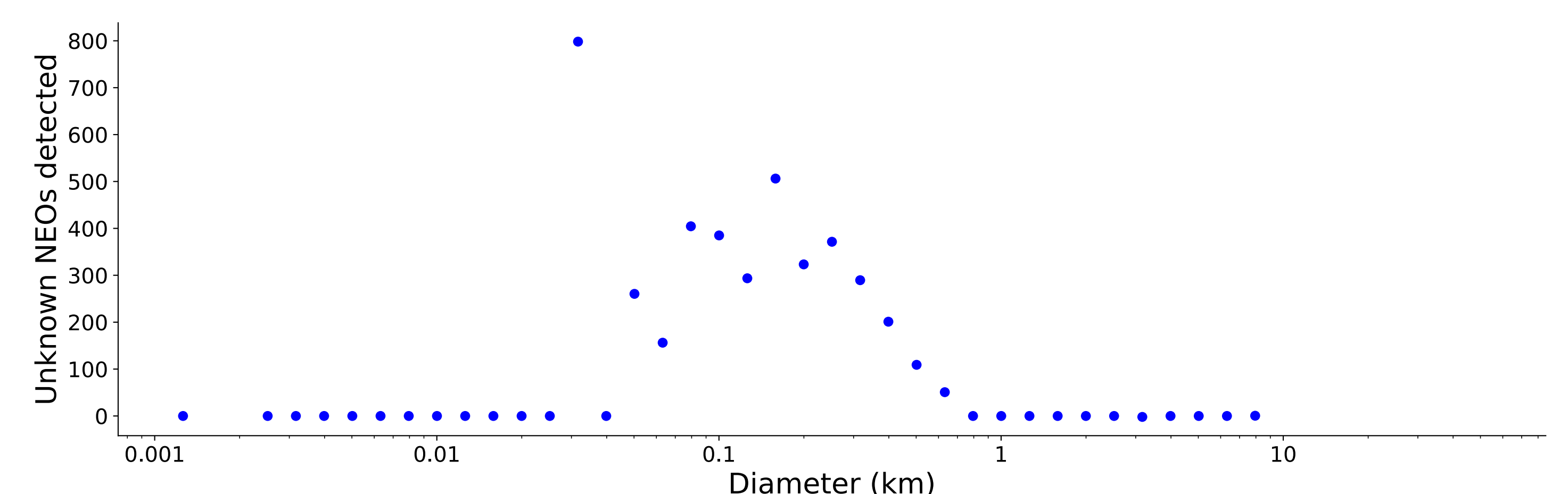


Figure 6: Amount of NEOs that will be discovered by BlackGEM as a function of NEO diameter

Email: jasperpostema@hotmail.nl

My Bachelor Thesis:



university of
 groningen

faculty of science
 and engineering

kapteyn astronomical
 institute

