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## A3\_2: Waving to the ISS

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### Abstract

The aim of this paper was to determine how long it takes the ISS to repeat an orbit. We created an orbital simulation of the International Space Station (ISS) using official orbital data, from which we found that the time taken for the ISS to travel along a pre-travelled orbit (same latitude and within  $1^\circ$  longitude) was 6 days 21 hours and 21 minutes.

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### Introduction

The International Space Station (ISS) orbits Earth in a near circular orbit, with an eccentricity of 0.000741 [1]. As the ISS orbits around the planet, the planet rotates beneath it, and so the ISS does not travel above the same points on Earth with each orbit. The aim of this article is to determine how frequently the ISS passes directly above the same position on Earth, thus allowing you to wave directly upwards at the astronauts on board the ISS.

### Theory

To perform this analysis we first obtained a recent Two Line Element set (TLE) [1] for the ISS's orbit. This is an industry standard format that contains the eccentricity, right ascension of the ascending node (RAAN), inclination, argument of perigee, mean anomaly as well as details on the identity of the satellite. The useful data from the TLE has been presented in Table 1.

We then took this information and entered it into the General Mission Analysis Tool (GMAT) and produced an orbital simulation for the ISS.

GMAT is an open source piece of software that allows you to simulate orbits and gather meaningful data about the orbits. Figure 1 shows our simulation of the ISS after 12 hours. The orbital simulation was run until we observed the spacecraft following a pre-travelled orbital path. Please note, the ISS does not need to be directly overhead to be seen, and multiple different orbits can be observed from the same position on Earth. The aim of this study is to determine when exactly the ISS follows a previously travelled orbit, which we have defined as the point when two orbital paths are at the same latitude and within  $1^\circ$  longitude of each other.

### Results

From our simulation we observed that the ISS follows an orbital path within  $6^\circ$  longitude of a previous path after just 23h 24m, and follows within  $3^\circ$  longitude of a previous path after 3d 14h 26m. It takes 6d 21h 21m for the ISS to orbit along a path that is within  $1^\circ$  longitude of a previous orbit, where all instances are at the same latitude.

