The Transit Simulator : From dark to sparks

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The public as experimentator, one model to rule all types of audiences and activities

Origin

The idea that birthed the Transit Simulator is quite simple : swap the positions of the public and the scientist. This way the audience becomes the experimentator and can prepare its hypotheses before confronting them to the data from the experiment as real scientist do. The plus is that with this model they can also see the physical phenomenon producing the data in real time.

The model was entirely designed by us, taking care to balance attractivity for various audiences, outreach potential and practical aspect such as size an costs. The first version was built for the "Nuit des Chercheurs" (Researcher's night), in late summer 2022. Given the success it had, we decided to improve it to increase again the panel of activities we can propose with it.

Fig. 1 : The Transit Simulator such as presented during the "Printemps des Sciences" (Spring of Sciences), in Liège in March 2023

We decided to use the model as a tool for various activities for all types of audiences, from young kids to veteran scientists from all fields.

The upgrade focused on adding a second rotation mode (slower) to produce real-looking transits in the light curve as well as strengthening the model for use on extended period of time, up to 5 hours continuously.

Description

The **motor** powers the gears and allows for 2 rotation modes:
- FAST: for easy observations by the public through the aperture.
- SLOW: for better light curve plotting.

The different **gears** control the planet's periods in a similar way than for real ones. The closest planet is the fastest and their speed decreases with their distance to the star.

An **aperture** is carved at the long end of the box for any observer to experience by eye the transits of the star by the different planets and thus observe the real physical phenomenon associated with the data..

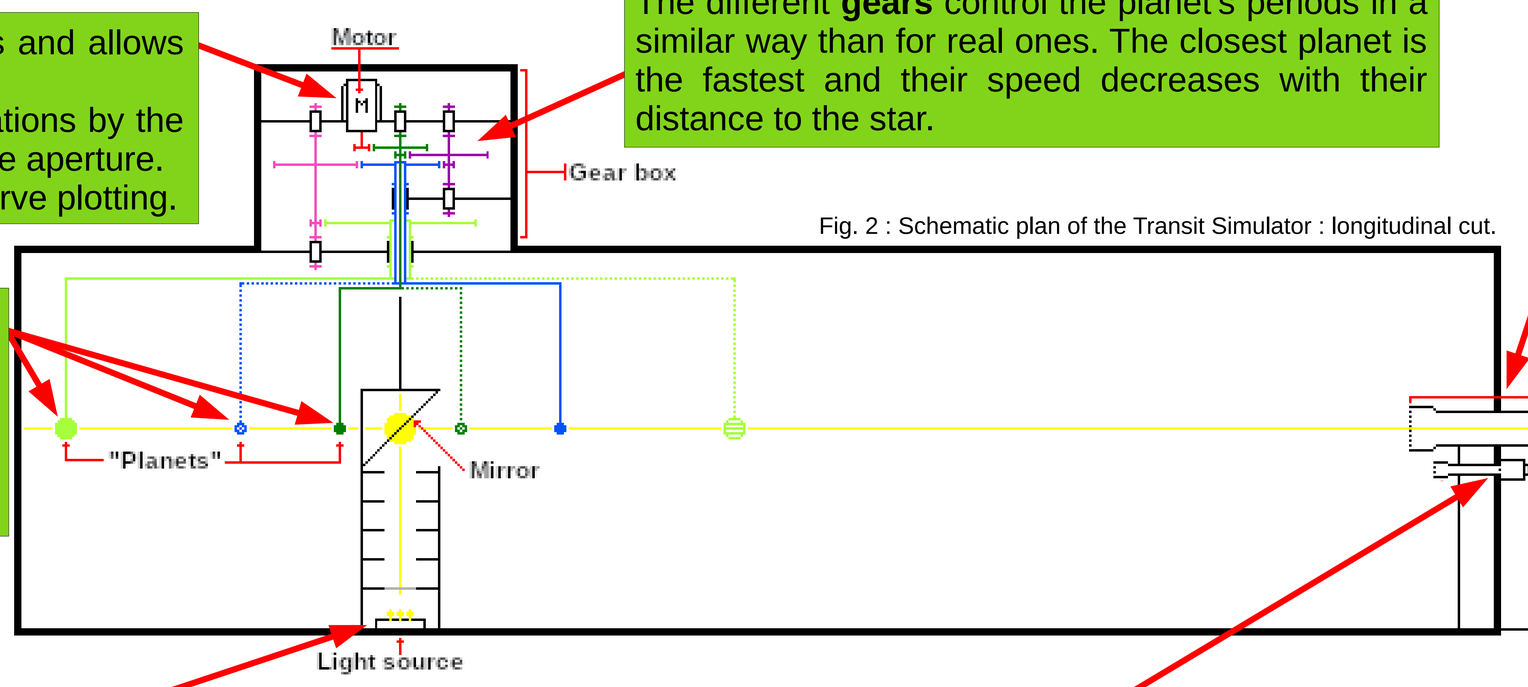

Fig. 2 : Schematic plan of the Transit Simulator : longitudinal cut.

Marbles represent the planets of the system. The length of the hanging ropes is such that the planets and the star lie in the same horizontal plane (for transits to happen)

A **LED lamp** is used as light source. It is placed at the bottom of a "light tower" and is reflected by a small mirror pointed towards the long end of the box. This mirror acts as the star of the system. This configuration has been selected to avoid any light scattering in the box.

A **light sensor** is attached against the inner wall, next to the aperture. It monitors the flux of the star over time.

The sensor is connected to a **computer** in which a homemade software is converting the flux into a light curve. This light curve is then shown in real time on the screen of the computer and provide the same data as the ones we use to detect real planet.

Fig. 3 : The gears (top), the "light tower" (bottom) in which the led lamp is located, and the planets' suports (centre).

Past and current uses

The model was first presented to the general public for the Nuit des Chercheurs 2022 in Liège. The audience was of all types as the event took place in one of the biggest malls of the city, while people were shopping. Then, in January 2023 we were tasked to develop an outreach-exercise for high school students with a duration of 2 to 3 hours. We trained them to the detection of planets using the transit method and tasked them with determining the number, size and period of the planets in the Transit Simulator.

In March 2023 at the Printemps des Sciences, once again the Transit Simulator was sollicited. We developped animations for primary schools pupils that came for two days during the event. Later in the month, a secondary school in Visé (20km from Liège) asked us to come and present a 2h outreach session during the lunch break. We adapted our animations to the level of the students and brought the model with us. Given the success among the students (and the staff), the organisers extended the event to 4 hours and proposed us to come again next year for a full day this time.

Fig. 4 : The Transit Simulator during a presentation to a small group of students that took place in the secondary school of Visé, near Liège in late March 2023.

Perspectives for future uses

Support to practical classes in 2 different courses at the Université de Liège:
- In the "Introduction to Astrophysics" course given in the Physics Bachelor program, for the understanding of planetary systems' structures and properties.
- In the "Exoplanetology" course given in the Space Sciences Master program, for the development of tools and skills in planetary detection by the students as a project.

More annual outreach events in Liège and close cities, including "Nuit des chercheurs" (Researchers night), "Printemps des Sciences" (Spring of Sciences) with various approaches based on the model.

More outreach visits in schools and interactions with young students to participate in the opening of their minds to astronomy and science in general.

We were also asked to bring it to a youth astronomy summer camps from the Université Libre de Bruxelles to support space-related presentations and present an activity for several hours.

The Transit Simulator was built thanks to the participation of the Département d'Astrophysique, Géophysique et Océanographie of the Université de Liège and improved thanks to the participation of the Young Minds initiative of the European Physical Society. We are very grateful to these contributors that made this project possible.