Experimental determination of the radius of Stanton

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Abstract

Using the Ray Theorem, we show how the radius or diameter of the star Stanton can be determined experimentally in a simple way, i.e. with distances directly accessible in Star Citizen.

Introduction

In elementary geometry, the ray theorem is one of the most important statements. It deals with distance ratios and enables to calculate distances in many geometric considerations. The second ray theorem is illustrated in Fig. 1.

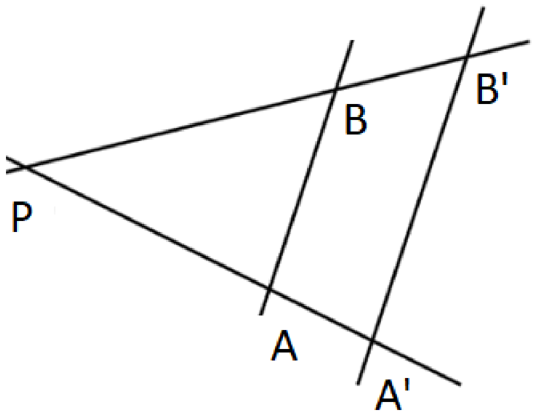

Fig. 1: According to the second ray theorem, sections on parallels behave like their corresponding sections measured from the vertex on the same straight line. This is formulated in Eq. (1).

It is:

$$\frac{|AB|}{|A'B'|} = \frac{|PA|}{|PA'|} = \frac{|PB|}{|PB'|} \tag{1}$$

Realization

Applying the theorem Eq. (1) to the situation shown in Fig. 2. under exclusion of diffraction and gravitational lensing effects, we obtain the simple equation

$$\frac{A}{a} = \frac{B}{b} \tag{2}$$

Rearrangement of Eq. (2) for the searched diameter *B* of Stanton results in

$$B = \frac{A}{a} * b \tag{3}$$

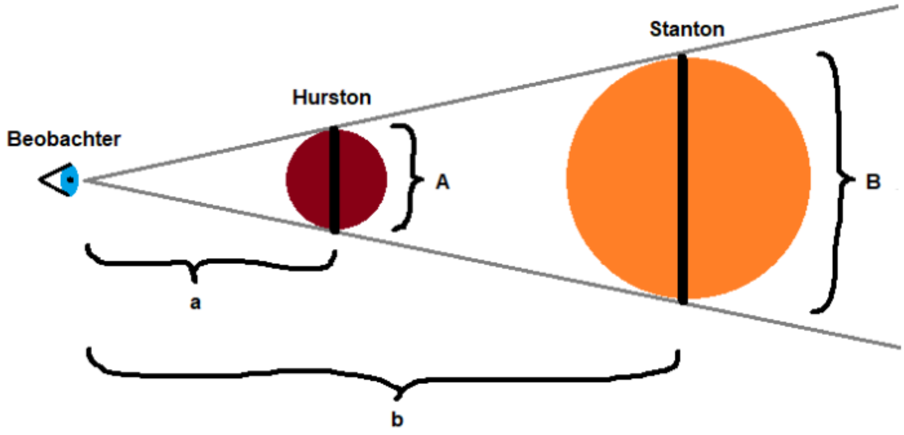

Fig. 2: If a celestial body with known radius (or diameter) covers another celestial body exactly from any observation point and if the distances from the observation point to the first and to the second body can be measured, the diameter of the second celestial body can be calculated using the ray theorem Eq. (3).

We have determined the radius (or diameter) of Hurston to be 1,000 km (or 2,000 km) already previously. For our present measurement, we fly as far away from Hurston towards Stanton until we reach the point where Hurston covers Stanton as exactly as possible.

a) b) c) d)

Fig. 3: Picture series of the flight to the point of eclipse. The viewing direction in picture d) corresponds exactly to the viewing direction in the **Fig. 2**.

Fig. 4: Close-up of the solar eclipse. Note the very nicely visible corona of Stanton.

At the point of eclipse, we read the distance to Hurston and Stanton in the Mobi glass. Using Eq. (3), the diameter of Stanton is then calculated as follows:

$$\frac{\emptyset\ Hurston * Distance\ to\ Stanton}{Distance\ to\ Hurston} = \emptyset\ Stanton$$

$$\frac{2.000\ km\ \cdot 12.869.661\ km}{19.800\ km} = 1.299.966\ km$$

Result

The diameter of Stanton is calculated to be 1,299,966 km, or about 1.3 million km. Stanton's radius of 650,000 km is therefore somewhat smaller than the radius of our Sun (696,342 km).

Further considerations and conclusions

Since our sun and the star Stanton belong to the same kind of star (G-star), the densities and masses should also be approximately proportional. (Because of the gradual density distribution in the star this assumption is not exactly correct).

Therefore, with 0.93 times the radius (and thus 0.81 times the volume or mass) for Stanton, Kepler's constant becomes 1.23 times larger. According to Newton’s gravitation laws it is:

$$C \approx \frac{4\pi^2}{G * M} \tag{4}$$

with C being Kepler's constant, G the gravitational constant and M the mass of Stanton. With this approximation and under exclusion of relativistic effects as well as with Kepler's third law given in Eq. (5), saying that the ratio of the square of the orbital period of the planets and the cubes of the large semiaxes of the planetary orbits is a constant

$$C = \frac{T^2}{a^3} \tag{5}$$

the astronomical data given in **Tab 1**. can be calculated for the Stanton system.

Tab. 1: Astronomical data calculated using equations (4) and (5) for the Stanton system.

	Hurston	Crusader	ArcCorp	microTech	Reale Erde
Radius of planetary orbit [Mio. km]	12,85	19,15	30,37	57,15	149,6
Circumference of planetary orbit [Mio. km]	ca. 81	ca. 120	ca. 179	ca. 273	ca. 940
Orbital period [in earth days]	10,19	18,55	33,67	63,37	365,26
Orbital velocity [km/s]	91,66	75,09	61,55	49,85	29,78
Self-Rotation in [h] = 1 planetary day	2,5	6	3	4	24
Number of planetary days per planetary year	97,87	74,19	269,39	380,19	365,26

Outlook

The measurement of a star system, i.e. the determination of relevant astronomical quantities, such as the diameter of stellar objects, their distance to each other, their orbits and orbital times, as well as numerous conclusions derived from them, such as day-night cycles, partial or complete solar eclipses at given locations in the system, etc., is not only a rewarding enterprise for exploration gameplay. Rather, it is often the in-depth knowledge of such relationships that enables us to make the necessary preparations for undertakings of many different kinds. In doing so, of course, we don't want to forget that Star Citizen is a game and not an exact simulation of the universe.