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CCD Observationes of Geostationary Satellites

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Geostationary satellites are supposed to «stand still» above the equator of the Earth, since they rotate with the same angular speed around the Earth's axis as the Earth does. My CCD observations show different behaviours of these objects: first, they are not still but they move along complicated loops; second, they are obscured by the Earth's shadow during some particular days in the year; third, they vary their brightness significantly.

During the last summer and autumn I observed many times geostationary satellites with my 20 cm Baker-Schmidt camera and my Celestron 20 cm telescope. My first idea was very simple: since those satellites are supposed to stand still above us, I was interested to discern at least one of them with the aid of my brand new CCD camera. It was quite easy to spot Meteosat 5; the 20 seconds CCD image popped out an «earth-fixed» 12 magnitude object, while the stars left significant trails across the image.

A geostationary satellite lies some 36 000 km above the Earth's surface and rotates with the same angular speed around the Earth axis as the Earth does. Various sources (the Moon for example) impose forces on the spacecraft and try to pull it out of its fixed place above the Earth; the satellite starts to move around this point. Usually, this is an oscillation of the form of a figure of eight. To verify this I tried to capture this tiny movement during one whole night. For this I used my Celestron at f/10. The addition of hundreds of CCD pictures showed the amazing orbit of the satellite!

The sunlight illuminates those satellites. They shine normally between 11 and 13 magnitude, but I noticed a very low luminosity (about 15 mag. or fainter) at the very beginning and at the end of the night and, big increase during the middle of the night (reaching up to 10 mag.). The time of this brightness-increase depends on the specific satellite. In some pictures I also noticed, near 1 o'clock in the morning, the complete vanishing of the light reflection. In an interval of several weeks around the spring and autumn equinoxes, the Earth-shadow crosses the equator-plane and switches off the sunlight. This event may last for up to 75 minutes!

The geostationary orbit is a densely populated place. Due to its peculiar characteristics, this orbit becomes more and more crowded. Normally geostationary satellites do not lie very close together. I observed the six Astra

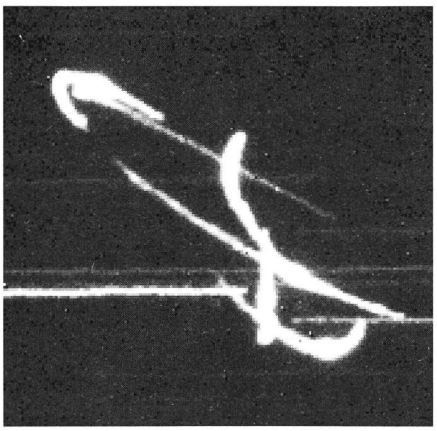


Fig.5: This picture consists of the superposition of eighty CCD pictures. It shows the path of the 6 ASTRA geostationary satellites during 6 hours and 46 minutes. The first picture began at 18h20m UT of October 25th 1997. The last picture ended at 00h56m UT of October 26th 1997. Every frame of the 80's lasted 60 seconds. I took the pictures with my Celestron 8 inch telescope at f/6,3 and my Hi-SIS22 CCD camera, in 2x2 binning mode. The telescope was earth-fixed. North is up, East is left. The square field of view spans 7,3 x 7,3 arcminutes. Interesting features are the changing brightnesses of the satellites and the apparent west-shift of the ASTRA-complex.

Fig.1: This 20 seconds CCD picture shows the 12th magnitude point of light of the geostationary Meteosat-5 satellite.

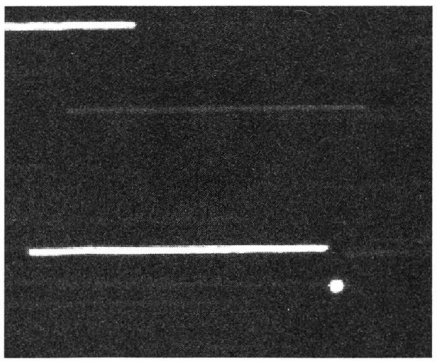


Fig.2: This picture shows the trace of a geostationary satellite during 6 hours and 13 minutes during the night between 31st August and 1st September 1997. It is the result of the superposition of 750 CCD-pictures, 26 seconds each. During this time the satellite was moving slowly from up left to down right. I took the pictures with my C8 (f:10) and my Hi-SIS22 CCD camera, in 2x2 binning mode. The telescope was fixed, in effect one can see the horizontal trails left by the stars. (North is up, East is left).
From the up-left point to the down-right point I calculated a tangential shift of roughly 300 arcseconds (± 4 arcsec), which implies a tangential shift of approx. 54 km (at a rough estimated height of 36'000 km above the Earth's surface). Another thing to note is the eclipse of the satellite by the Earth's shadow (missing points in the middle of the trace). It starts approx. at 01h55m local time (± 2 min) and ends at 02h09m (± 2 min).

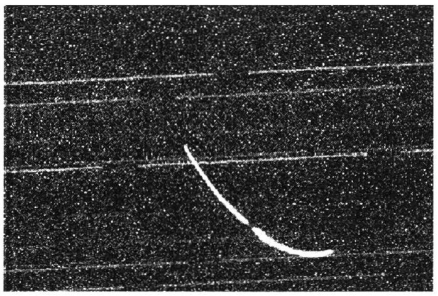
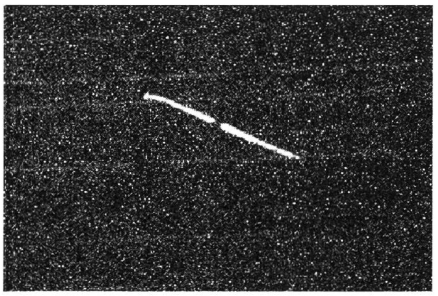


Fig. 3: This picture shows the trace of a geostationary satellite during 8 hours and 36 minutes. It is the result of the superposition of 1020 CCD-pictures, 26 seconds each. The first picture began at 21h04m (local time) of the 1st September. The last picture ended at 05h40m (local time) of the 2nd September. During this time the satellite was moving from up left to down right.
An interesting feature is the eclipse of the satellite by the Earth's shadow (missing points in the middle of the trace). The eclipse starts approx. at 01h51m local time (±2 min) and ends at 02h13m (±2 min). The «shadowing» lasted 22 minutes. Also, one will note an interesting feature near the start position. It is also interesting to note that the satellite brightens as it nears the center of the trace (i.e. near 2 o'clock local time in the morning).



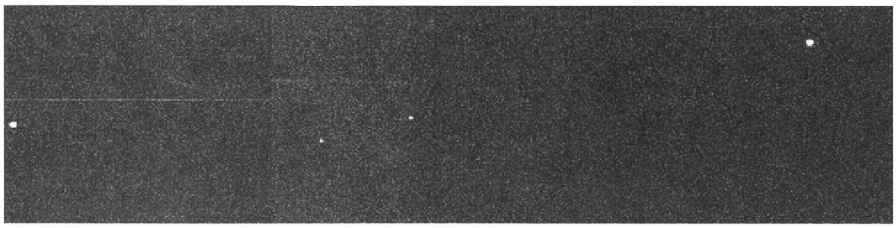


Fig.4: This image consists of the composition of 3 CCD pictures showing the position of 4 geostationary satellites. The exposure time of every image was 60 seconds. C8, f:10 and Hi-SIS22 CCD camera, in 2x2 binning mode. The telescope was earth-fixed. North is up, East is left. The three pictures were taken between 02h20m UT and 02h31m UT of September 4th 1997. The angular distance from the left to the right satellite is approx. 29 arcminutes. The 2 satellites in the middle are fainter.

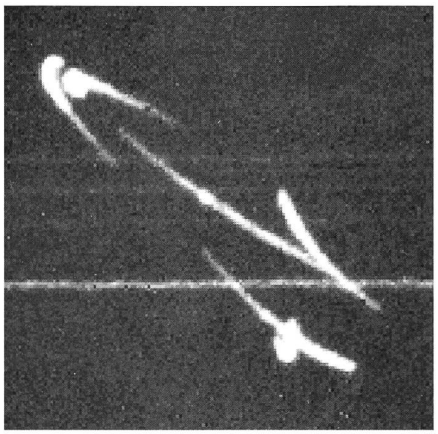


Fig.6: This picture consists of the assembly of 47 CCD pictures. They show the sky-motion of the 6 ASTRA geostationary satellites during 4 hours and 40 minutes. The first picture began at 17h20m UT of October 26th 1997. The last picture ended at 22h00m UT of October 26th 1997. Every frame lasted 60 seconds. Celestron 8 inch telescope at f/6,3 and Hi-SIS22 CCD camera, in 2x2 binning mode. The telescope was earth-fixed. North is up, East is left. The square field of view spans 6,5 x 6,5 arcminutes. Note the changing brightnesses of the satellites and the apparently chaotic movements of the satellites.

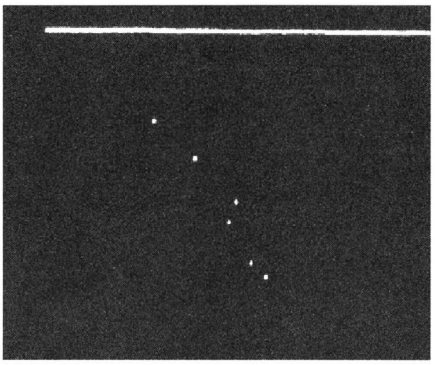


Fig. 7: This 60-seconds picture shows the six ASTRA geostationary satellites. The camera was earth-fixed. The magnitude of every satellite is between 12 and 13. North is up, East is left. The square field of view spans roughly 10 x 10 arcminutes.

satellites (they are TV broadcasting satellites) for some nights. They also show sudden light increases and fadings.

I produced also some MPG-movies of those objects. These movies can be downloaded from the Swiss Astronomical Society site:
http://www.astroinfo.ch/aida/sposetti/

Many thanks for the contribution of Mr. ARNOLD BARMETTLER, who encouraged and helped me to write this article.

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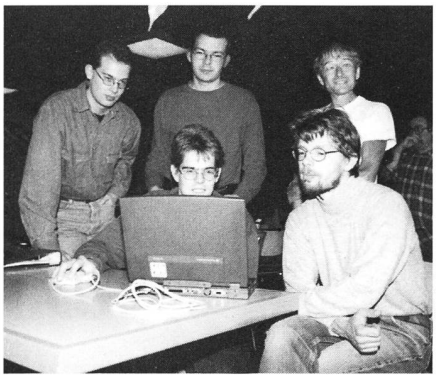
Von irdischen zu himmlischen Schleiern

Besuchsbericht von der Starparty 1997

BRUNO BLEIKER

Es war Freitagmorgen, den 29. August 1997. Von meinem Balkon aus blickte ich über die Surselva im Bündneroberland. Dicke Wolken hingen über dem Tal und versperrten den Sonnenstrahlen zum Teil das Vordringen auf den Boden. Zwischen den Lücken erkannte man die Bergspitzen, die bei dem Kälteeinbruch am Vortag und in der darauffolgenden Nacht einen Zuckerguss erhielten. Die Wetterprognosen verhiessen zwar gutes Wetter, aber bei dem Anblick kamen mir Zweifel auf, ob wir auf der Starparty was sehen würden. Meine Dreipässefahrt über Oberalp, Furka und Grimsel liess ich auf alle Fälle fallen, vielleicht auf dem Rückweg, dachte ich mir. So nahm ich denn um die Mittagszeit die Strecke von Brigels über Zürich auf den Gurnigel unter die Räder, um nach 7 Stunden und mehr als 350 km mit einem Umweg auf besagtem Berg anzukommen.



Figur 1: Draussen ist's regnerisch und nass, während man drinnen im trockenen Internet surft – auf dem trockenen.

Das Wetter im Berner Oberland war in der Tat vielversprechend. Nach der Begrüssungstour und dem Bezug von Unterkunft (HD-Soldat Läppli lässt grüssen) machte ich mich mit einem Entrecôte Café de Paris beobachtungsbereit.

Um 22.00 Uhr war es komplett dunkel, und da ich schon als letzter diniert hatte, war es auch kein Wunder, dass ich als letzter auf den Beobachtungsplatz gelangte. Der Platz war bereits sehr gut ausgelastet und auf den ersten Blick hatte ich Mühe, in der Dunkelheit für mein Instrument einen Standort zu finden. Aber mit ein bisschen gut Zureden war auch für mich noch ein Plätzchen zu finden, und so kam auch dieses Jahr wieder eines dieser allseits beliebten Schmidt-Cassegrain-Teleskope zum Einsatz.

Beim anschliessenden Rundgang ging es darum, die diesjährige Gerätepallette zu eruieren. Zur Freude aller hatten auch diesmal wieder Dobsonteleskope den Weg auf den Gurnigel gefun-