ALTIUS Measurements Scenario for Stellar Occultations: Star Choice and Optimization of the Satellite Movements.

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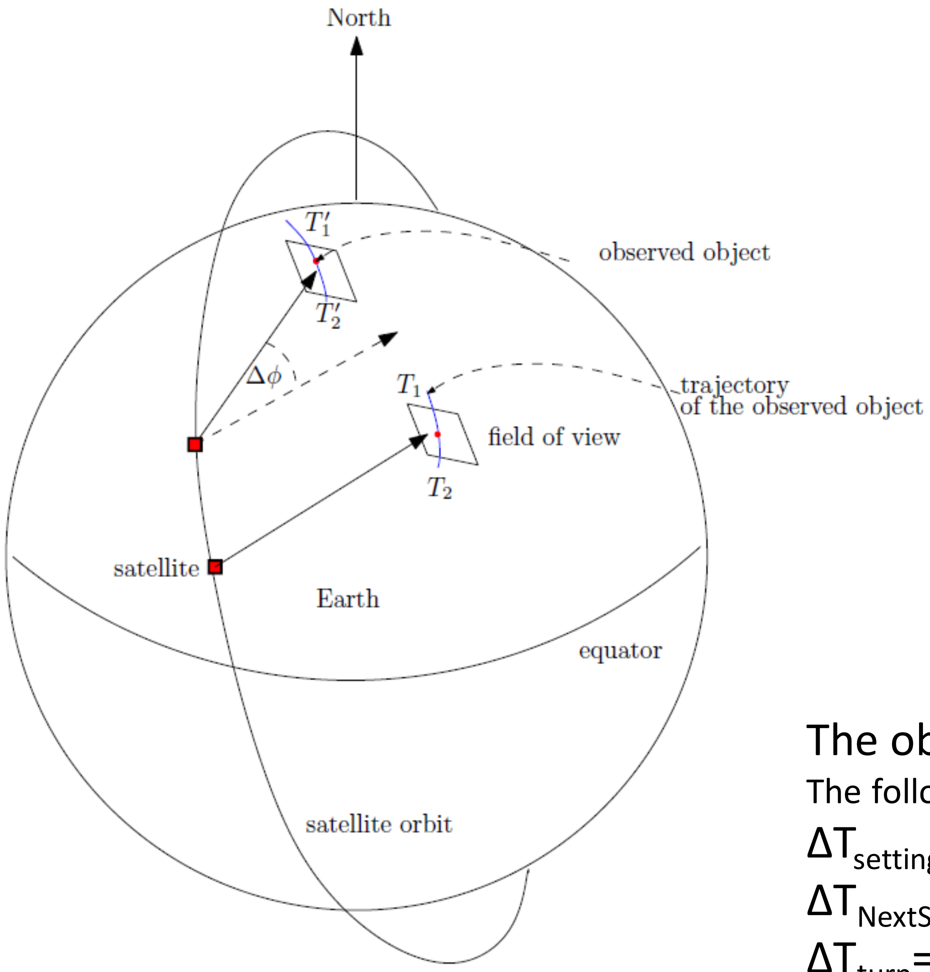
Star chain for stellar occultation measurements



ALTIUS is a micro-satellite mission whose main objective is to monitor the distribution of stratospheric ozone in the Earth's atmosphere. A typical orbit consists of the following measurement sequence: sunrise occultation, limb scattering observations in the dayside, sunset occultation and, in the nightside, stellar, planetary and lunar occultations.
The sequence of stars, moon and planets that will be observed during each night-part of the orbit should be planned to ensure the best spatial coverage and to minimize the time it takes for the satellite to turn to a new target. Here we present the algorithm which is one of the candidates to solve this problem.

The procedure of ALTIUS occultation measurements is the following: the instrument is pointed to the area where the setting (or rising) object is expected to appear, and stay in the same position until the object of interest finishes crossing the field of view. Then it turns, pointing to the direction where the next setting object is expected to appear.
Fig. (left) shows the instrument field of view for two consecutive pointing directions. A setting star is crossing the field of view in both cases.

The objective is to minimize the total turn angle $\Sigma_i \Delta\phi_i$.

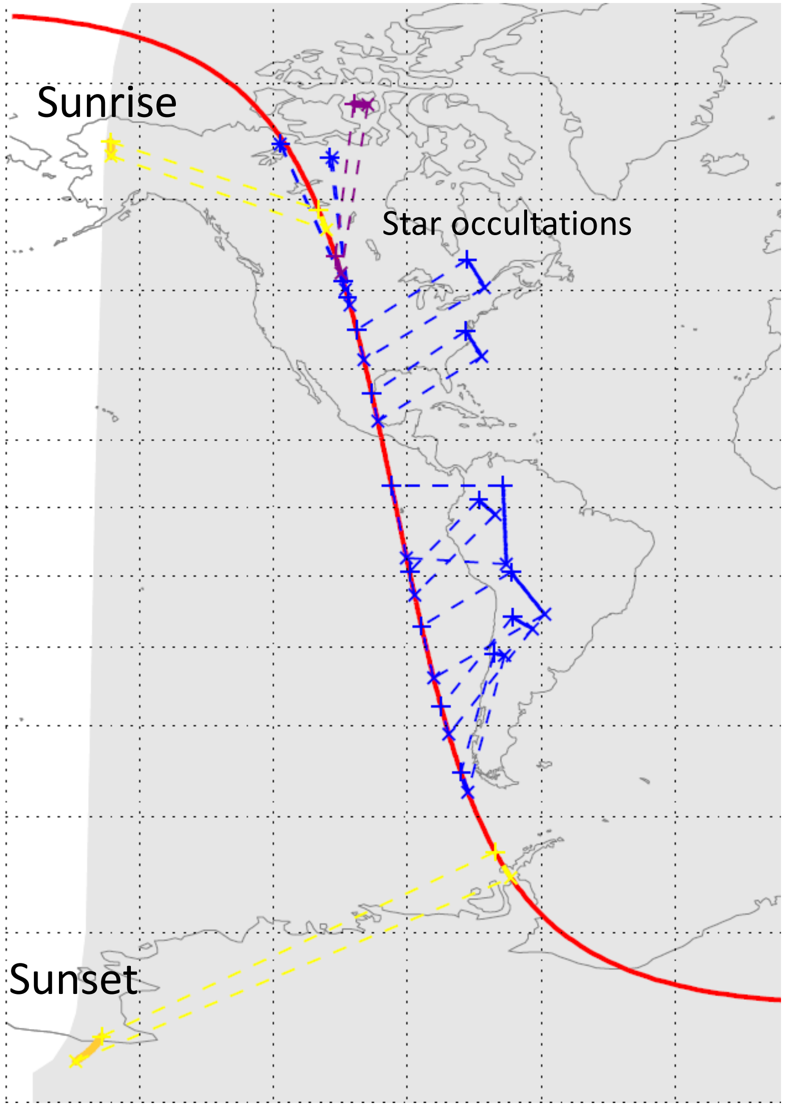
The following time intervals were considered:

$\Delta T_{setting}=T_2-T_1$ is the time necessary to cross the field of view by the setting star,

$\Delta T_{NextSetting}=T'_2-T'_1$ is the time necessary to cross the field of view by the next setting star,

$\Delta T_{turn}=\Delta\phi/\omega_{satellite}$ is the time necessary to turn for the new target observation.

Weighted oriented graphs and the Dijkstra's algorithm



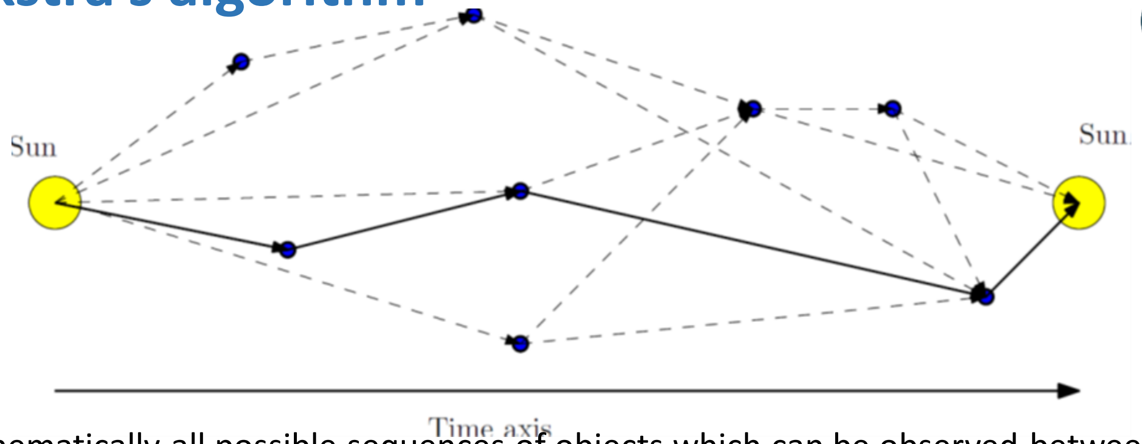


Fig.(Up) presents schematically all possible sequences of objects which can be observed between the sunset and the sunrise.

If $T_{turn} < T_{NextSetting}$ and if $T_{NextSetting} > 0$ then

$$E_{ij} = T_{turn}.$$

In other cases $E_{ij} = \infty$.

The matrix E describes a weighted oriented graph with vertices that represent objects to be observed. Weighted edges of the graph are presented by elements of matrix E. The beginning of the graph is the sunset and the end is the sunrise. We use the **Dijkstra's algorithm** (http://en.wikipedia.org/wiki/Dijkstra) to find the shortest path in the graph. The shortest path means that we minimize the total time necessary to turn the satellite between the consecutive targets.

More complex expression for weights of graph edges can be used to minimize not only waste time between the consecutive targets but also include other parameters, for example stellar magnitude:

$$E_{ij} = T_{turn} + 10^{k+m}$$

where k is a parameter which varies between 1 and 3 and m is the stellar magnitude.