3D REPRESENTATION OF THE NON-ROTATING ORIGIN

O. DE VIRON, V. DEHANT
Royal Observatory of Belgium
Avenue Circulaire, 3, B-1180, Brussels Belgium
e-mail: v.dehant@oma.be

ABSTRACT. In the frame of the IAU working group of Nomenclature in Fundamental Astronomy (of which one of the objectives is to make educational efforts for addressing the implementation of the IAU 2000 Resolutions for a large community of scientists), we have developed a set of didactic animation in order to give a physical understanding to the concept of non-rotating origin (NRO). In this paper, we give a short explanation on the existing animations, in order to encourage their use. A complete zip file with all the material is available on : http://danof.obspm.fr/iauWGnfa/Educational.html.

1. ROTATION OF THE EARTH

The first movie shows that the Earth rotation is not constant. At first, it was used to define the timescale, but with the increasing precision of the measurement techniques, it became, at the end of the 18th century, rather obvious that the Earth rotation presents 3 types of variation:

- the Earth angular velocity is not constant, nor is the length-of-day,
- the Earth rotation axis moves in space,
- the Earth moves around its rotation axis.

Of course, in the real world, those three motions are mixed, and the Earth rotation is quite complicated.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/rotationterre.htm

2. THE EARTH REFERENCE SYSTEM

In some applications, the Earth reference system was defined from the rotation axis (Z axis) and the Greenwich meridian (X axis). For reference frame purposes, the use of the Tisserand axis of the Earth was the most common approach (i.e. the axis attached to the mantle and defining a reference frame where the positions of points attached to the solid surface of the Earth have coordinates which undergo only small variations with time, see McCarthy, 2003). Nevertheless, this definition generates practical issues when it came to the realization of the reference system. The definition is based on the position at the Earth surface of a set of well known reference station.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/systemeterrestre.htm

3. THE CELESTIAL REFERENCE SYSTEM

Originally, the Celestial reference system was defined from the positions of stars of which the proper motion was corrected. The Z axis was very close to the rotation axis and the X axis was defined in the direction of the vernal point, which is the intersection between the ecliptic plane and the equatorial plane. Nevertheless, this definition generates practical issues when it came to the realization of the reference system. Now, the reference system is based on a kinematical definition, making the axis directions fixed with respect to the distant matter of the universe (see McCarthy, IERS convention, 2003). The system is materialized by a celestial reference frame defined by the precise coordinates of extragalactic objects, such as quasars, BL on the grounds that these sources are so far away that their expected proper motions should be negligibly small.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/systemeterrestre.htm

4. REFERENCE SYSTEM TRANSFORMATION USING EULER ANGLE

In this movie, we show the Euler angle method to change from one reference frame to another, allowing to only rotate around the axes of a given reference frame. This method is used in the next section.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/anglesdeuler.htm

5. THE REFERENCE SYSTEM TRANSFORMATION

This set of two movies shows how it is possible to change from the terrestrial reference system to the celestial reference system. The first movie shows how it was done before the new conventions

This movie can be found on: http://www.observatoire.be/D1/DIDAC/anciennetransformationstsc.htm

The second movie shows how the new conventions allow to change reference frame.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/nouvelletransformationstsc

6. THE MOTION OF SOME PARTICULAR POINTS

It is important to note that any point of the celestial sphere can qualify for a possible Non-rotating origin (NRO), as it is not so much the point which is important, but its motion. In this movie, we consider some particular points of the celestial sphere, of which the motion is imposed by their definition, and we show that none of them can qualify for being an NRO, as their motions is inappropriate. In addition, we show what would be the motion of a NRO. The advantage of the use of the NRO is that there is no component of the motion along the Z-axis, allowing for a description of the Earth rotation as a pure Earth rotation angle (the Earth Rotation Angle, ERA, or stellar angle) independent of the changes in the orientation of the Earth and of the definitions of the reference frames.

This movie can be found on: http://www.observatoire.be/D1/DIDAC/originenontournante.htm