Analytical solution of the motion of the planets over several thousands of years

Pierre Bretagnon
Bureau des Longitudes

We present the connection between the general theories describing the motion of the planets over several million years and the secular variation theories, the validity interval of which is restricted to a few thousands of years. We note that the secular terms of the semi major axes correspond to long period terms in the general theories. These long period terms give, in the longitudes, terms with very large amplitude : 12 000" in the longitude of Saturn (54 000 year period), 20 000" in the longitude of Uranus (1 000 000 year period). The secular variation theories reach a great accuracy and allow to build the analytical solution of the difference TCB - TCG and the relations between the barycentric and geocentric space coordinates. The analytical theories of the motion of the Moon, the Sun and the planets built at the Bureau des longitudes are also useful to compute the precession and nutation expressions. Thus, we have computed, for the rigid Earth, the influence of the Moon, the Sun and all the planets on the potential of the Earth limited to $C_{j,0}$ for j from 2 to 5, $C_{2,2}$, $S_{2,2}$, and $C_{3,k}$, $S_{3,k}$ for k from 1 to 3.