THE ORBIT OF THE RADIOASTRON SPACE MISSION

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Main parameters of the orbit

THE ORBITAL PARAMETERS ARE STRONGLY EVOLVING WITH TIME (SEE FIGURES 1-5), THE AVERAGE VALUES OF THE MAIN ORBITAL PARAMETERS ARE GIVEN BELOW.

AVERAGE PERIOD P_{orb}=9.5 DAYS (7-10DAYS)

AVERAGE SEMI-MAJOR AXIS a=189000 KM

PERIGEE HEIGHT: FROM 500 KM (INITIAL VALUE) TO 70 000 KM

APOGEE HEIGHT: $\sim$ 300 000 - 400 000 KM INITIAL ECCENTRICITY $e = 0.956$

Details are at http://www.asc.rssi.ru/radioastron/description/orbit_ eng.htm

LAUNCH

THE SPACECRAFT WILL BE LAUNCHED FROM BAIKONUR LAUNCHING SITE ON A TRANSFER ORBIT. THEN THE ORBITAL BOOSTER WILL TRANSFER THE SPACECRAFT ON THE MISSION ORBIT. THE PARAMETERS OF THE MISSION ORBIT RIGHT AFTER THE LAUNCH ARE LISTED BELOW (defined with respect to the inertial Greenwich coordinate system fixed at the moment of launch):

$a = 155391.3$KM, $e = 0.956$, $I = 51,7$, $\omega = 317.5$, $\Omega = 9.092$

PERTURBATIONS OF THE ORBIT

THE MAIN PERTURBING FACTORS ARE DUE TO THE MOON AND THE SUN. A SPECIAL CHOICE OF THE INITIAL PARAMETERS OF THE ORBIT ALLOWS THE ORBIT TO EVOLVE ON A TIME SCALE OF 1.5 YEAR UNDER THE ACTION OF THESE FACTORS. THE CHARACTER OF EVOLUTION MAY BE APPROXIMATELY DESCRIBED AS FOLLOWS: THE ECLIPTIC LONGITUDE OF APOGEE $\sim$ 60 IS APPROXIMATELY CONSTANT WHILE THE NORMAL TO THE ORBITAL PLANE ROTATES (SEE FIGURES (3-4)). ALTHOUGH THE APOGEE DISTANCE IS OF THE ORDER OF THE MOON ORBIT THE SPACECRAFT NEVER COMES TO THE MOON CLOSER THAN 50 000 KM (FIGURE 5).

OTHER PERTURBING FACTORS

1) OTHER PLANETS: VENUS AND JUPITER ARE MOST IMPORTANT

2) NON-GRAVITATIONAL PERTURBATIONS: RADIATION PRESSURE OF THE SUN AND RAM PRESSURE OF THE SOLAR WIND ARE MOST IMPORTANT

3) NON-SPHERICAL COMPONENTS OF THE EARTH GRAVITATIONAL FILED: A) THE STATIC COMPONENT, MULTIPOLES UP TO 18^{th} ORDER MUST BE TAKEN INTO ACCOUNT (AT LEAST!). B) THE COMPONENT DETERMINED BY THE TIDAL INFLUENCE OF THE MOON: BOTH SOLID TIDES AND THE TIDES INDUCED IN THE OCEANS MUST BE TAKEN INTO ACCOUNT

ACCELERATIONS

IN ORDER TO FULFILL THE MISSION OBJECTIVES ALL ACCELERATIONS UP TO $10^{-6} cm/s^2$ MUST BE TAKEN INTO ACCOUNT. FOR THE TESTS OF GENERAL RELATIVITY AT LEAST TWO ORDERS OF MAGNITUDE SMALLER ACCELERATIONS MUST BE UNDER CONTROL. FOR COMPARISON I WOULD LIKE TO SHOW TYPICAL ACCELERATIONS ARISING FROM DIFFERENT PERTURBING FACTORS:

$$a_{MOON} = 10^{-4}(\frac{r}{10^4 KM})\frac{cm}{s^2}$$

$$a_{RADIATIONPRESSURE} \sim 10^{-6}\frac{cm}{s^2}$$

$$a_{SOLARWING} \sim 10^{-8} - 10^{-7}\frac{cm}{s^2}$$

ACCELERATIONS DUE TO THE RELATIVISTIC EFFECT OF GRAVITOMAGNETIC PRECESSION ARE MUCH SMALLER.

$$a_{GM} \sim 10^{-9}(\frac{10^4 km}{r})^{7/2}\frac{cm}{s^2}$$

THEREFORE, A SIGNIFICANTLY BETTER DETERMINATION OF THE ORBIT PARAMETERS MUST BE ACHIEVED IN ORDER TO USE THE SPACECRAFT FOR TESTING RELATIVISTIC EFFECTS. THIS MIGHT BE DONE WITH HELP OF THE LASER RANGING AND HIGH PRECISION CLOCKS INSTALLED ON-BOARD.

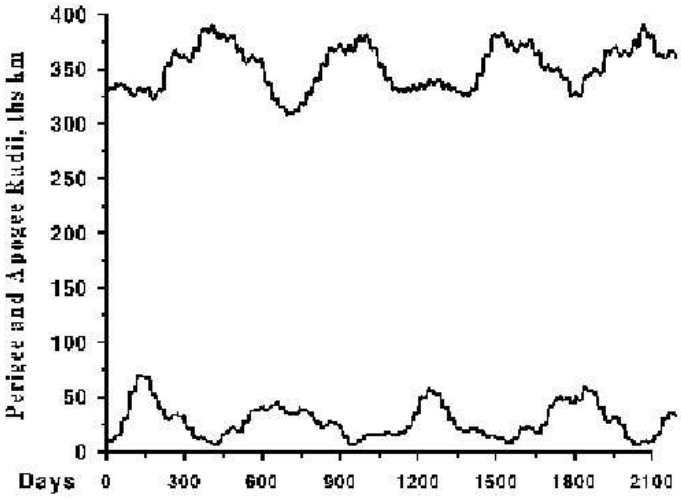

Figure 1: Evolution of perigee and apogee during 6 years.

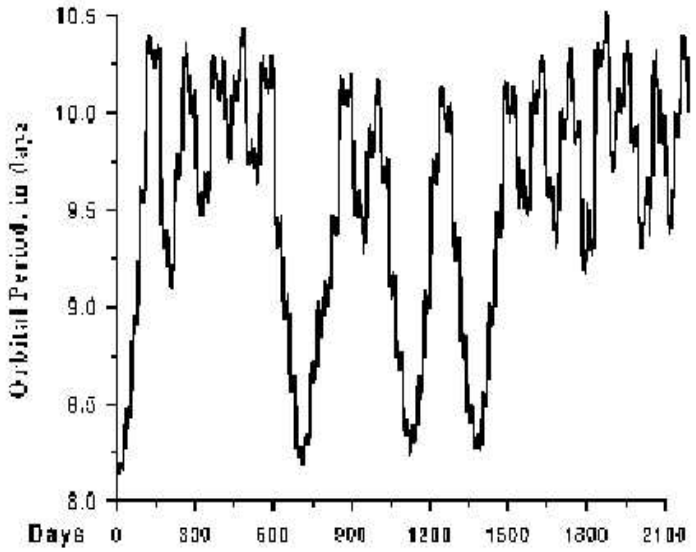

Figure 2: Evolution of the orbital period during 6 years.

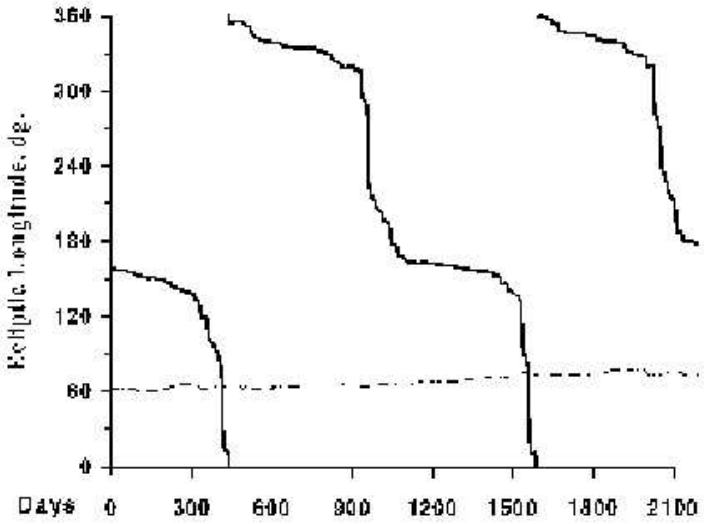

Figure 3: Evolution of the ecliptic longitudes of the apogee (dashed curve) and the normal vector to the orbital plane (solid curve).

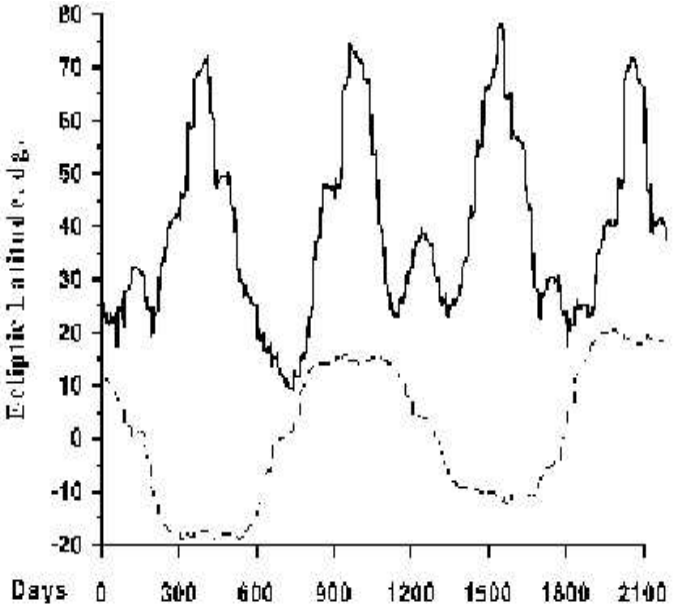

Figure 4: Evolution of the ecliptic latitudes of the apogee (dashed curve) and the normal vector to the orbital plane (solid curve).

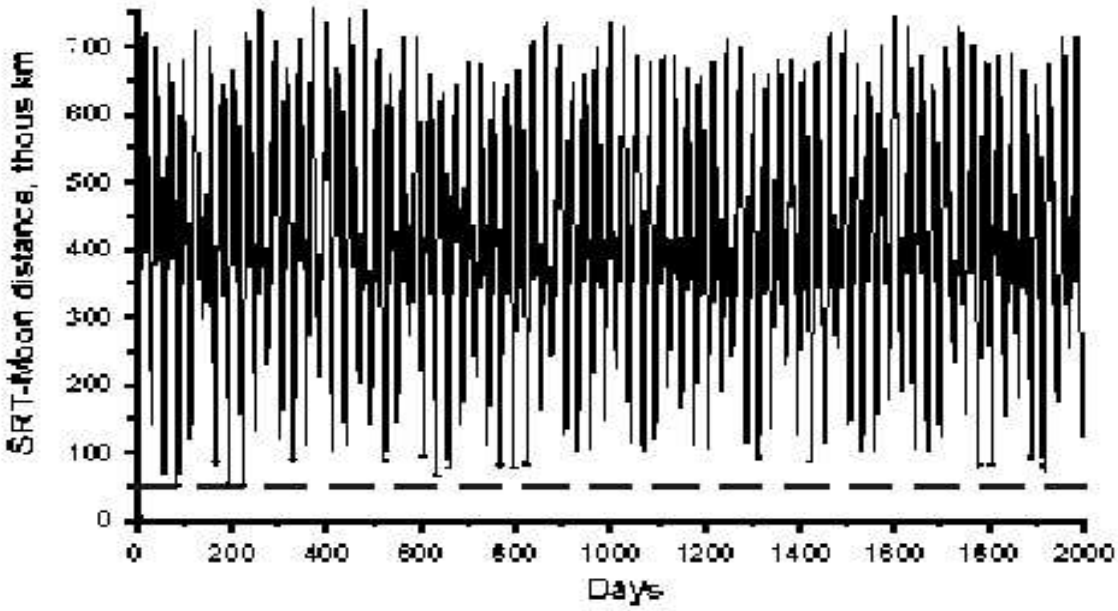

Figure 5: Evolution of s/c-Moon distance with time.