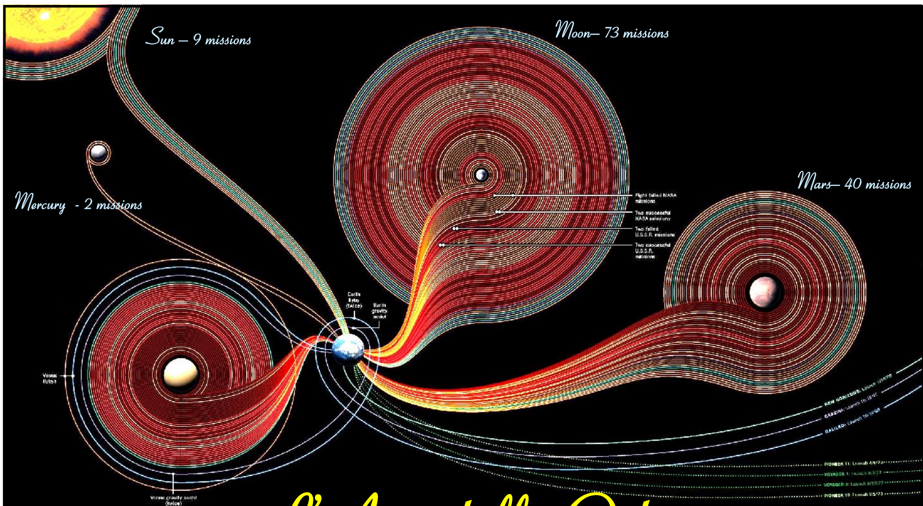


L'Arte delle Orbite

Alberto Buzzoni

Inaf – Osservatorio Astronomico di Bologna

Il Motore Primo: la Gravitá

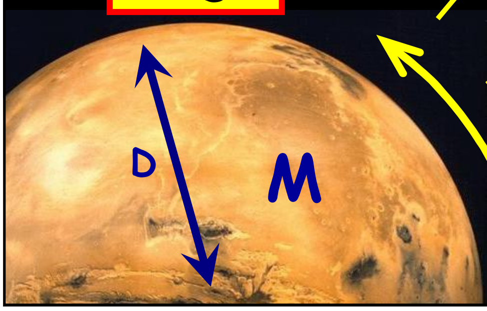
Accelerazione

Gravitazionale

$$g = \frac{GM}{D^2}$$

Centrifuga

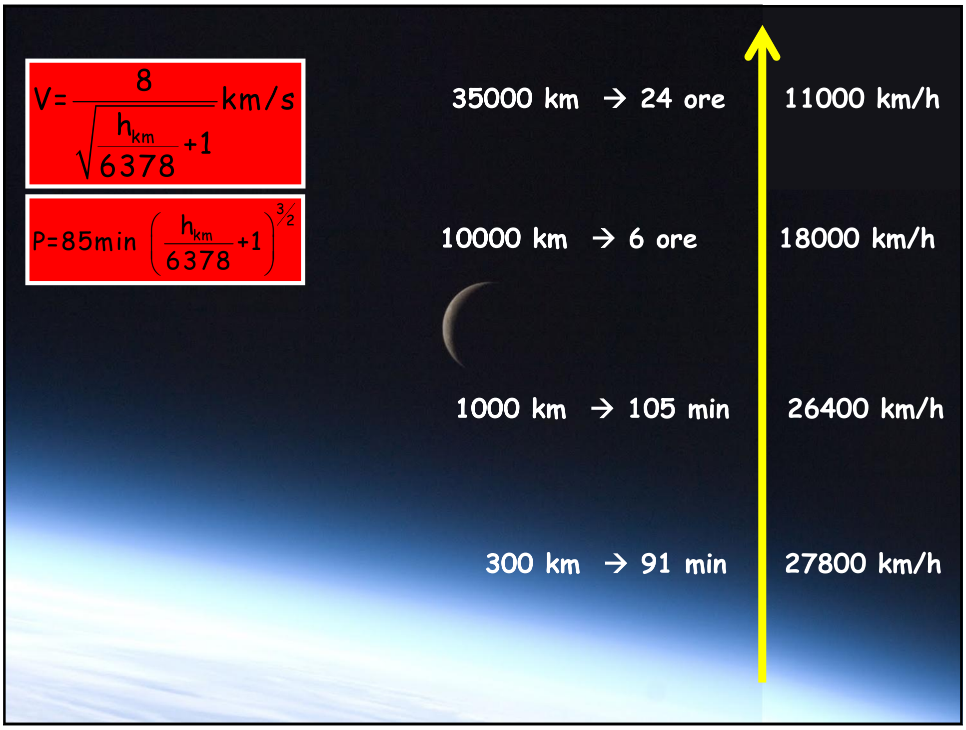
$$\omega^2 D = \left(\frac{V}{D}\right)^2 D$$



ω = velocita' angolare
M = massa del pianeta
D = distanza dal centro

$$V = \frac{8}{\sqrt{\frac{h_{km}}{6378} + 1}}\ km/s$$

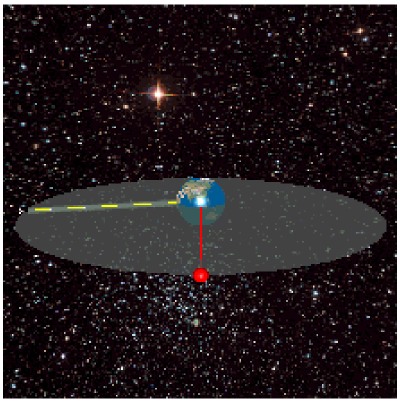
$$P = 85min \left(\frac{h_{km}}{6378} + 1 \right)^{3/2}$$



L'orbita geostazionaria

$H = 35,786\ km$

$P = 23h\ 56m$



October 1945 **Wireless World** 305

EXTRA-TERRESTRIAL RELAYS

Can Rocket Stations Give World-wide Radio Coverage?

By ARTHUR C. CLARKE

ALTHOUGH it is possible, by a suitable choice of frequencies and routes, to provide telephony circuits between any two points or regions of the earth for a large part of the time, long-distance communication is greatly hampered by the peculiarities of the ionosphere, and there are even occasions when it may be impossible. A true broadcast service, giving constant field strength at all times over the whole globe would be invaluable, not to say indispensable, in a world society.

Unsatisfactory though the telephony and telegraph position is, that of television is far worse, since ionospheric transmission cannot be employed at all. The service area of a television station, even on a very good site, is only about a hundred miles across. To cover a small country such as Great Britain would require a network of transmitters, connected by coaxial lines, waveguides or VHF relay links. A recent theoretical study[1] has shown that such a system would require repeaters at intervals of fifty miles or less. A system of this kind could provide television coverage, at a very considerable cost, over the whole of a small country. It would be out of the question to provide a large continent with such a service, and only the main centres of population could be included in the network.

The problem is equally serious when an attempt is made to link television services in different parts of the globe. A relay chain several thousand miles long would cost millions, and transoceanic services would still be impossible. Similar considerations apply to the provision of wide-band frequency modulation and other services, such as high-speed facsimile which are by their nature restricted to the ultra-high-frequencies.

Many may consider the solution proposed in this discussion too far-fetched to be taken very seriously. Such an attitude is unreasonable, as everything envisaged here is a [illegible] extension of develop[illegible] in the last [illegible] particular the perfection of the long-range rocket of which V2 was the prototype. While this article was being written, it was announced that the Germans were considering a similar project, which they believed possible within fifty to a hundred years.

Before proceeding further, it is necessary to discuss briefly certain fundamental laws of rocket propulsion and "astronautics." A rocket which achieved a sufficiently great speed in flight outside the earh's atmosphere would never return. This "orbital" velocity is 8 km per sec. (5 miles per sec), and a rocket which attained it would become an artificial satellite, circling the world for ever with no expenditure of power—a second moon, in fact.

The German transatlantic rocket A10 would have reached more than half this velocity.

It will be possible in a few more years to build radio controlled rockets which can be steered into such orbits beyond the limits of [illegible] atmosphere and left to broad[illegible]t scientific information back to the earth. A little later, manned rockets will be able to make similar flights with sufficient excess power to break the orbit and return to earth.

There are an infinite number of possible stable orbits, circular and elliptical, in which a rocket would remain if the initial conditions were correct. The velocity of 8 km/sec. applies only to the closest possible orbit, one just outside the atmosphere, and the period of revolution would be about 90 minutes. As the radius of the orbit increases the velocity decreases, since gravity is diminishing and less centrifugal force is needed to balance it. Fig. 1 shows this graphically. The moon, of course, is a particular case and would lie on the curves of Fig. 1 if they were produced. The proposed German space-stations would have a period of about four and a half hours.

It will be observed that one orbit, with a radius of 42,000 km, has a period of exactly 24 hours. A body in such an orbit, if its plane coincided with that of the

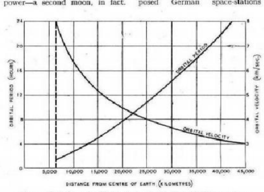
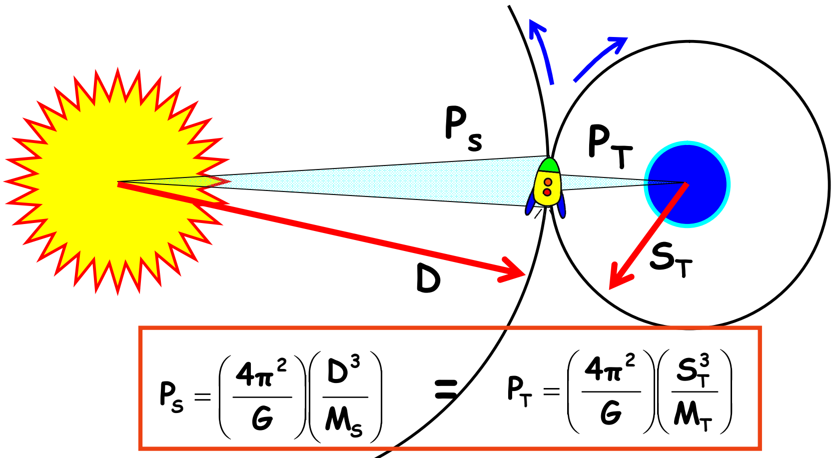


Fig. 1. Variation of orbital period and velocity with distance from the centre of the earth.

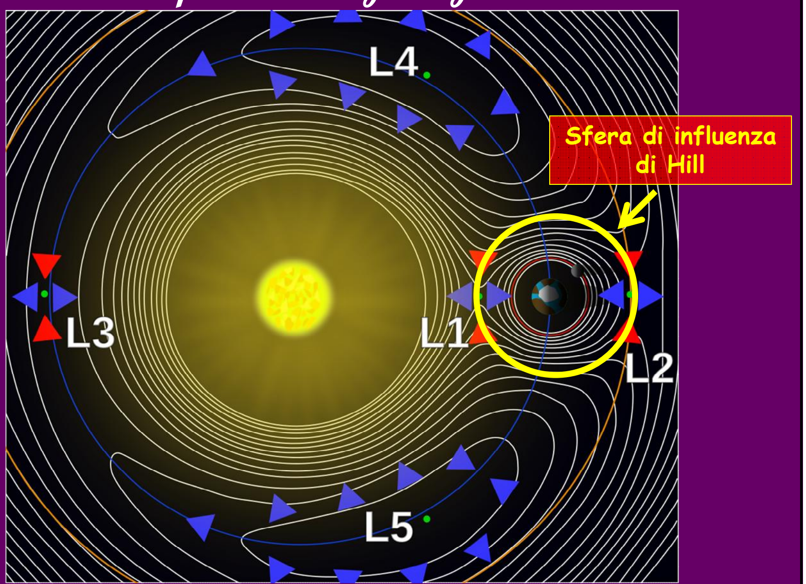
La Sfera di Influenza

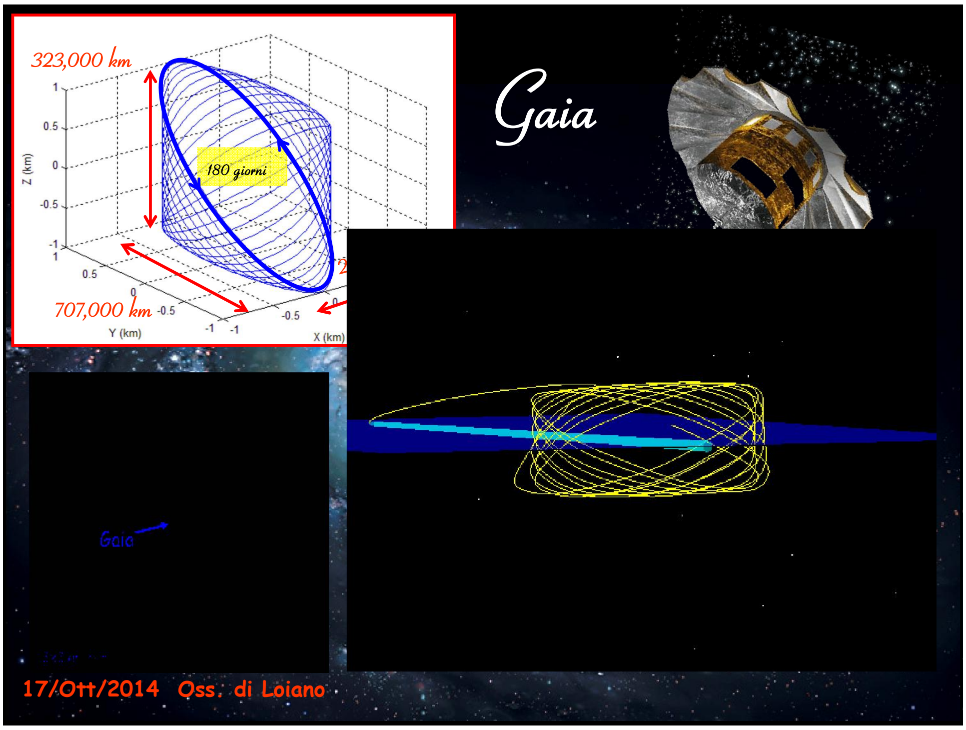


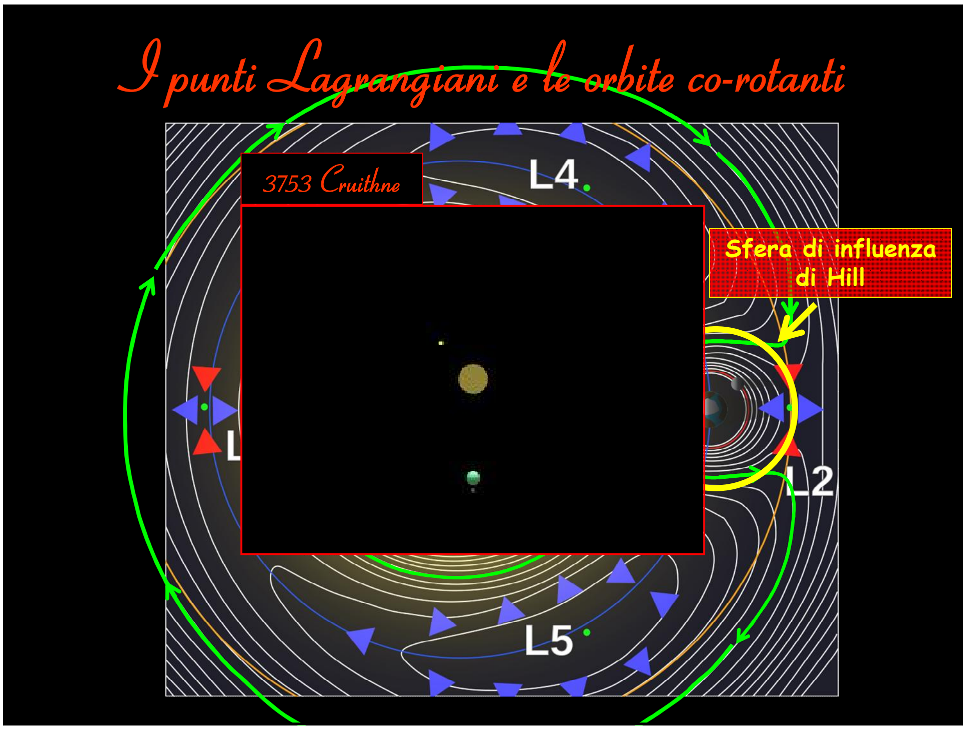
$$P_S = \left(\frac{4\pi^2}{G}\right)\left(\frac{D^3}{M_S}\right) = P_T = \left(\frac{4\pi^2}{G}\right)\left(\frac{S_T^3}{M_T}\right)$$

$$\left(\frac{M_T}{M_S}\right) = \left(\frac{S_T}{D}\right)^3 \longrightarrow S_T = D\left(\frac{M_T}{M_S}\right)^{1/3}$$

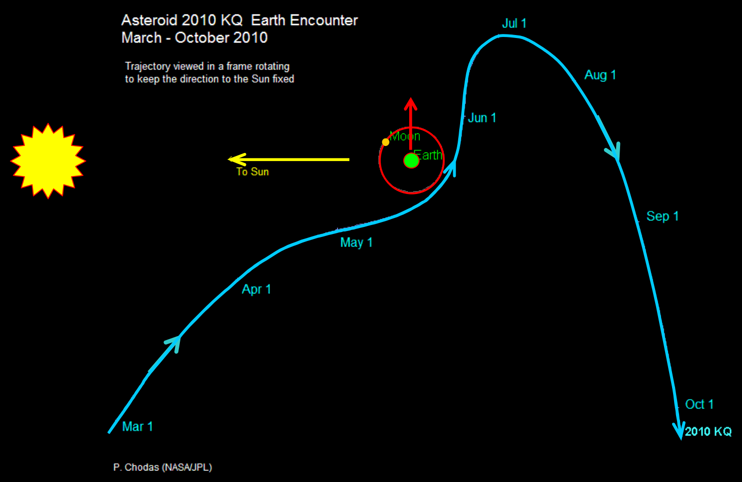
I punti Lagrangiani



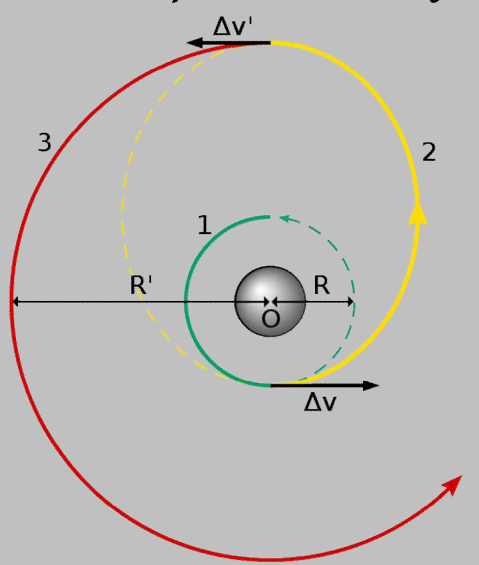

323,000 km
180 giorni
707,000 km
Z (km)
Y (km)
X (km)
Gaia
17/Ott/2014 Oss. di Loiano


I punti Lagrangiani e le orbite co-rotanti
3753 Cruithne
L4
Sfera di influenza di Hill
L2
L5

… A volte ritornano:
lo strano caso di 2010KQ



Passepartout verso gli altri pianeti:

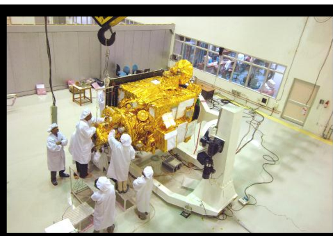


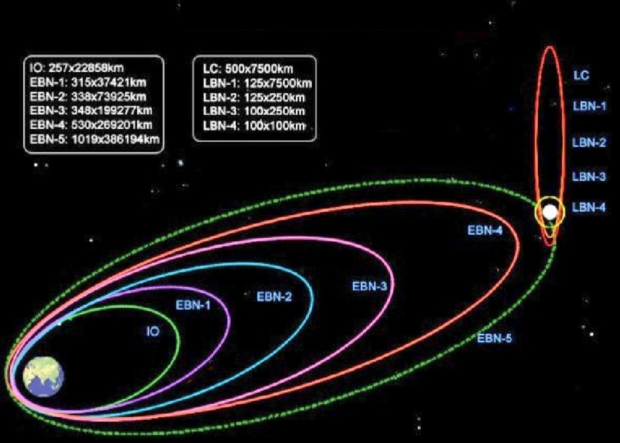
La Manovra di Hohmann
(1925)

Walter Hohmann
(1880-1945)

La Luna … low cost

La Missione Chandrayaan-1 (India - 2008)



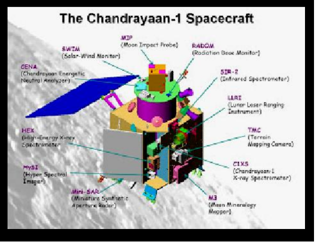


Massa: 1380 Kg

Potenza a bordo: 700 W

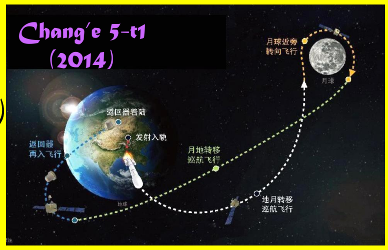
Costo: 71 M€

(51,000 €/Kg)



Passi Cinesi sulla Luna?

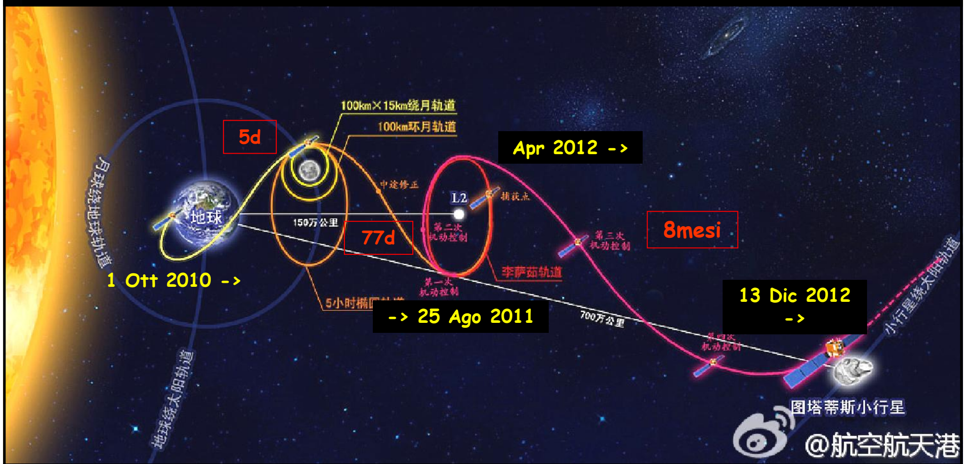
(le missioni Chang'e – Cina 2007-2017)



gli americani controllano, con LRO

Chang'e 2

verso Toutatis . . .



La "stele" di Rosetta

La missione **Rosetta**

Agenzia: **ESA**

Massa: 3000 kg

Potenza: 850 Watt

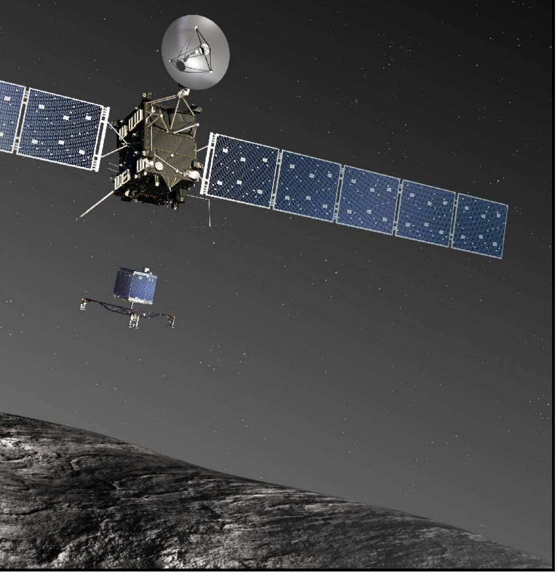
Target: **Cometa 67P/ Churyumov-Gerasimenko**

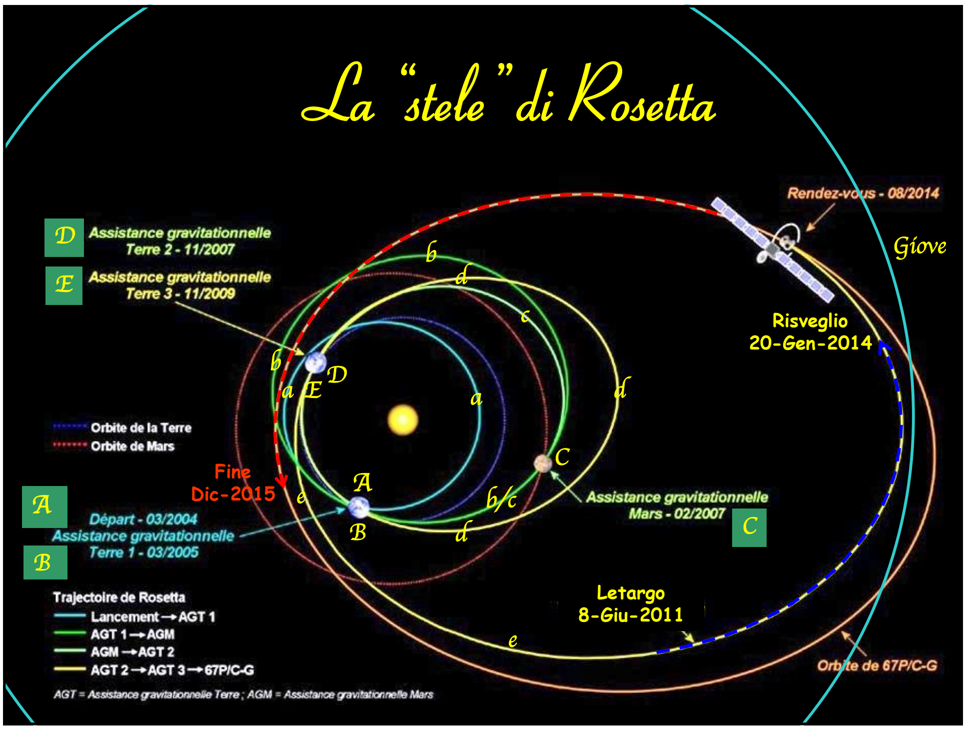
Lancio: 2 Mar 2004

Flybys:
25 Feb 2007 - **Marte** (250 km)
5 Set 2008 - **Steins** (800 km)
10 Lug 2010 - **Lutetia** (3200 km)

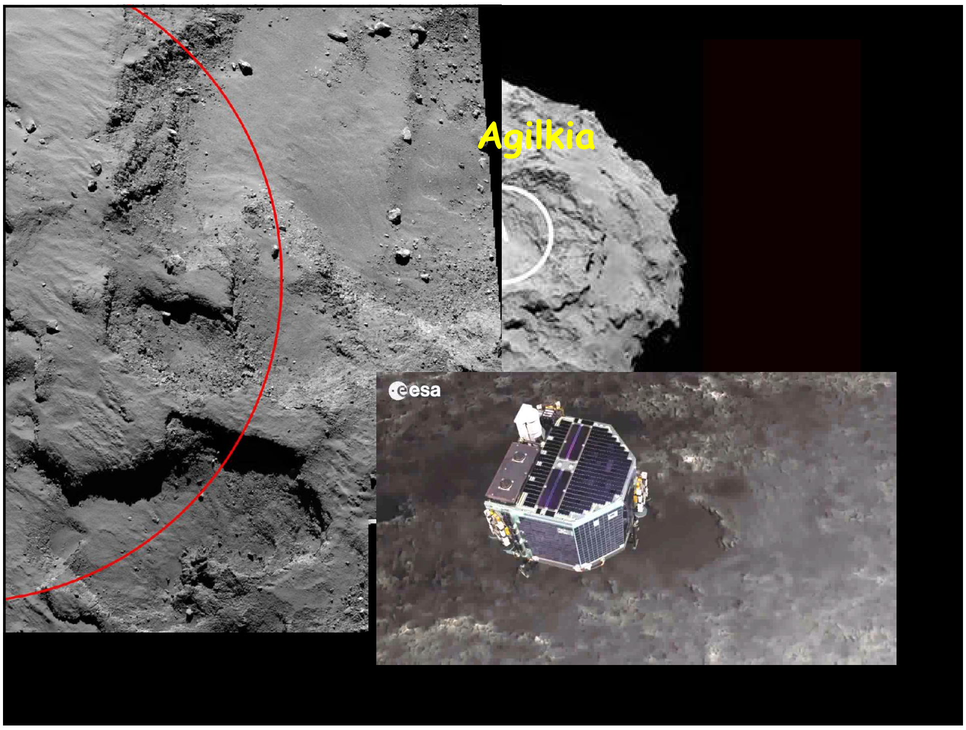
Orbita: **6 Ago 2014 (200 km)**

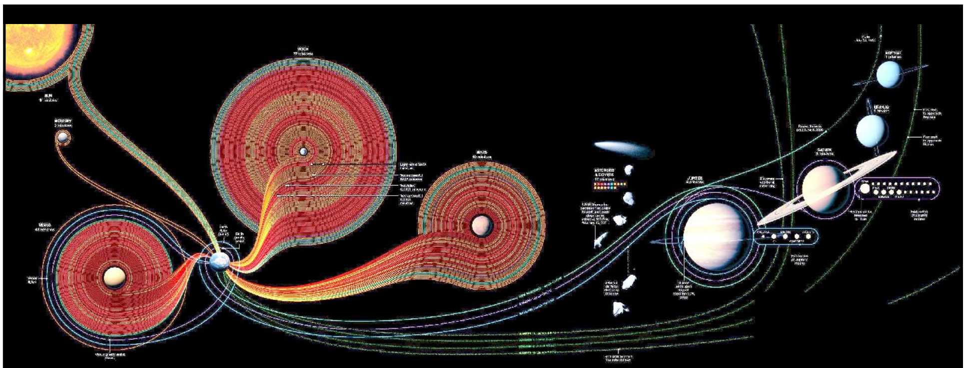
Atterraggio: **12 Nov 2014**




La "stele" di Rosetta
D Assistance gravitationnelle Terre 2 - 11/2007
E Assistance gravitationnelle Terre 3 - 11/2009
Rendez-vous - 08/2014
Giove
Risveglio 20-Gen-2014
Orbite de la Terre
Orbite de Mars
Fine Dic-2015
A Départ - 03/2004
B Assistance gravitationnelle Terre 1 - 03/2005
C Assistance gravitationnelle Mars - 02/2007
Letargo 8-Giu-2011
Orbite de 67P/C-G
Trajectoire de Rosetta
Lancement → AGT 1
AGT 1 → AGM
AGM → AGT 2
AGT 2 → AGT 3 → 67P/C-G
AGT = Assistance gravitationnelle Terre ; AGM = Assistance gravitationnelle Mars


Attrazione fatale . . .





L'Arte delle Orbite