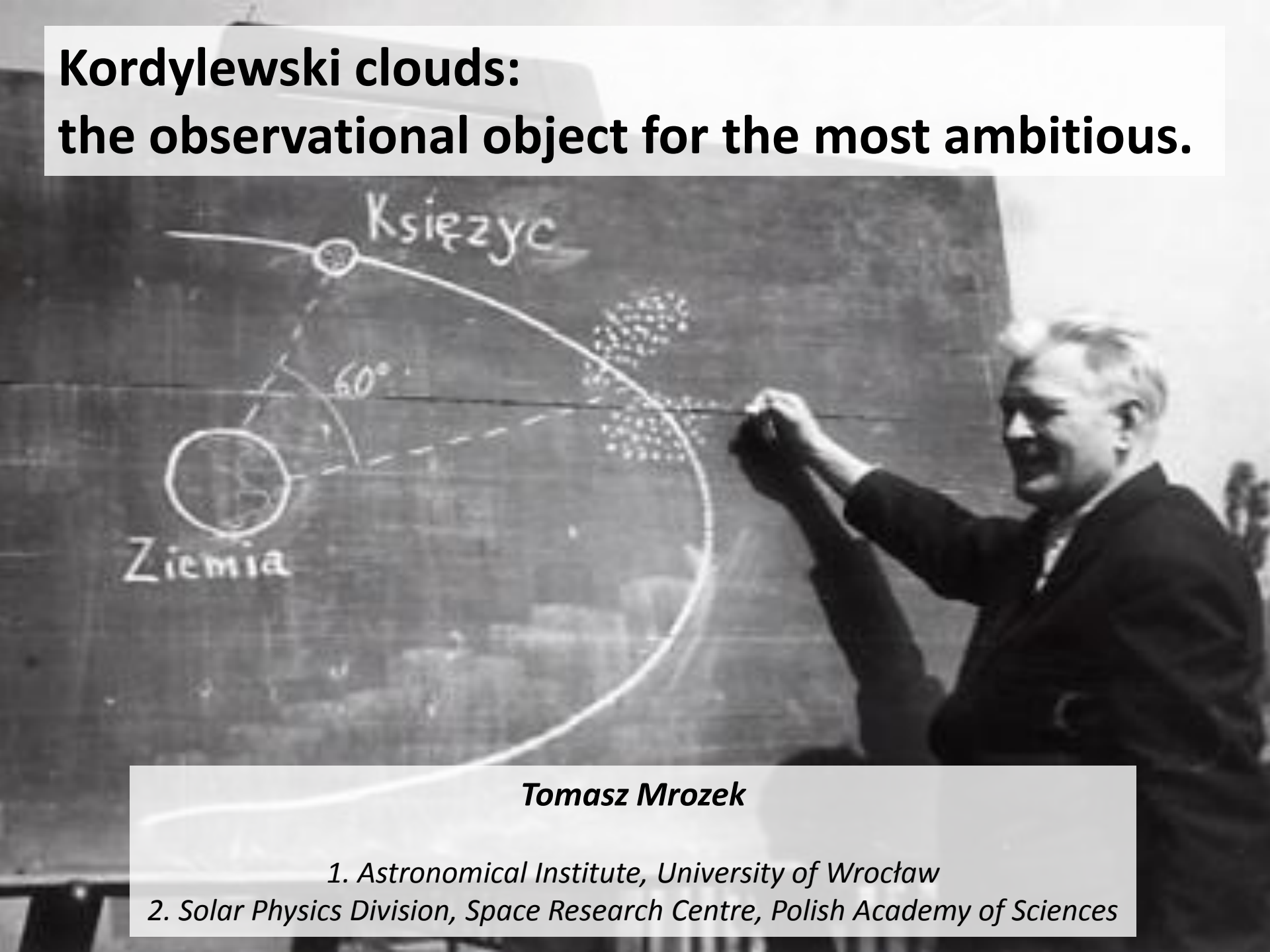
Kordylewski clouds:
the observational object for the most ambitious.



Tomasz Mrozek

1. Astronomical Institute, University of Wrocław
2. Solar Physics Division, Space Research Centre, Polish Academy of Sciences

A bit of history

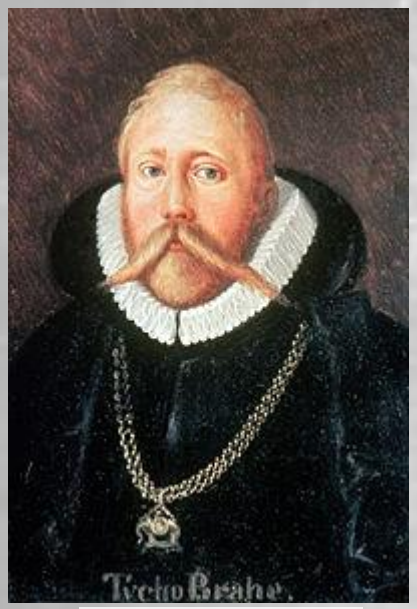
Tycho Brahe carried out extremely accurate visual observations.

Their accuracy has allowed Kepler to formulate three laws of planetary motion.

but…

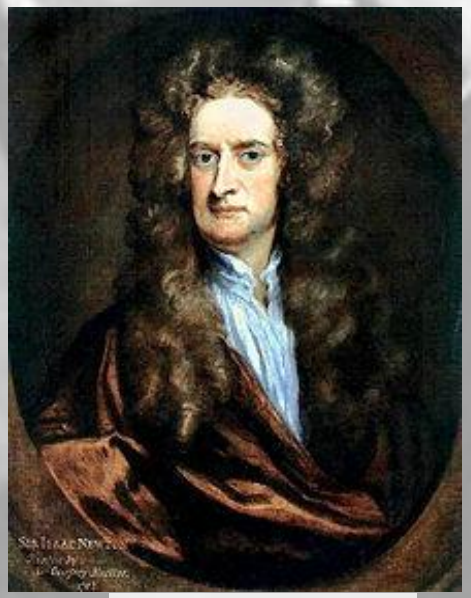
These laws only described observations. There was no theory. There was no physics that could explain them.

until…



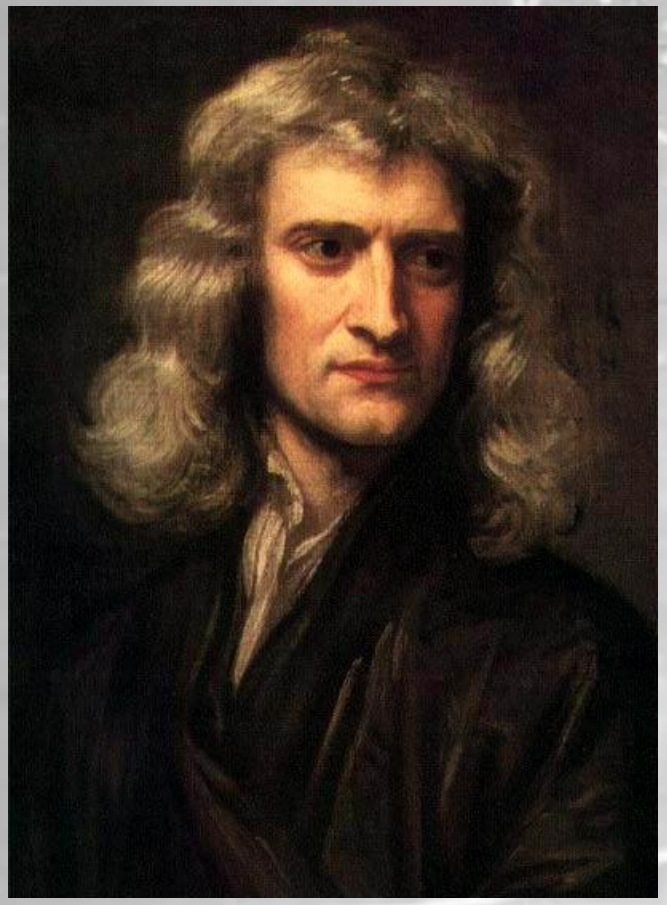
Tycho Brahe

Johannes Kepler



Isaac Newton

A bit of history



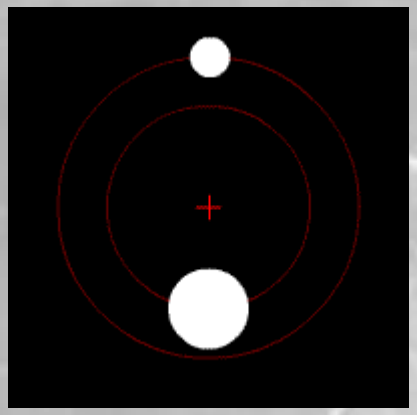
June 5th, 1686, *Philosophiae Naturalis Principia Mathematica* is published.

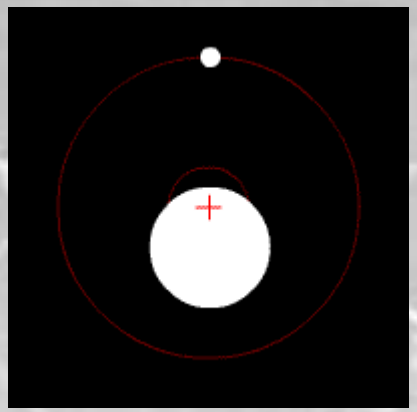
"I deduced that the forces which keep the planets in their orbs must [be] reciprocally as the squares of their distances from the centers about which they revolve: and thereby compared the force requisite to keep the Moon in her Orb with the force of gravity at the surface of the Earth; and found them answer pretty nearly."

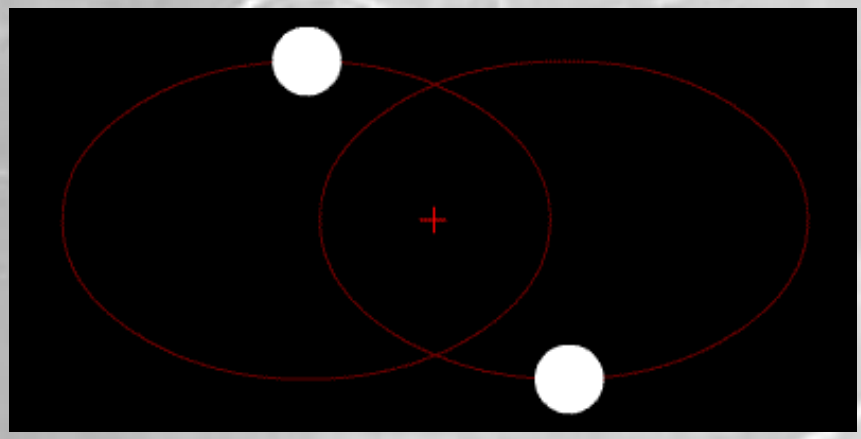
$$F = G\frac{m_1 m_2}{r^2}$$

Since then, Kepler's laws were justified physically and the rapid development of analytical methods for the study the motion of planets and other objects in the solar system took place.

A bit of history



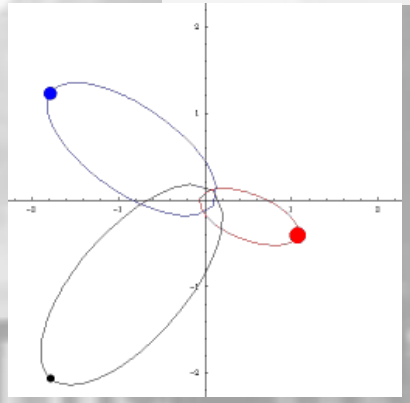


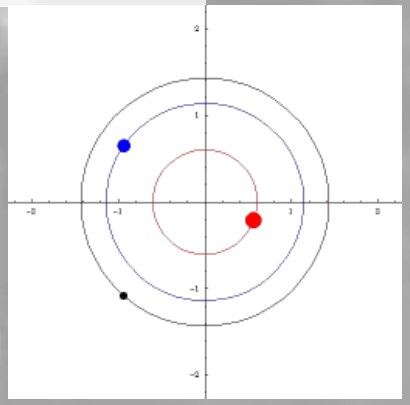


Laws of motion given by Newton made it possible to solve analytically two-body problem.

but…
The three body problem was not solved. Only constant-pattern solutions were found.

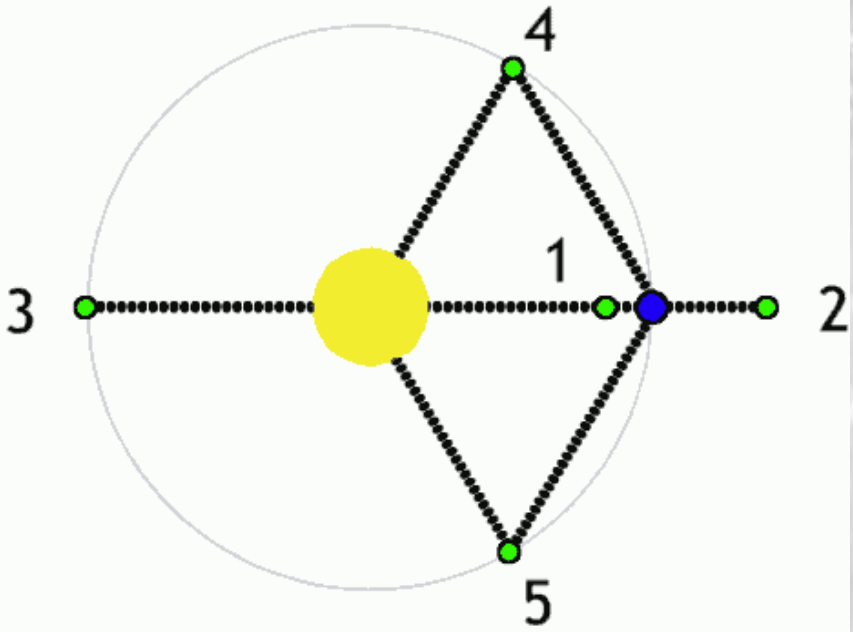
Joseph-Louis Lagrange

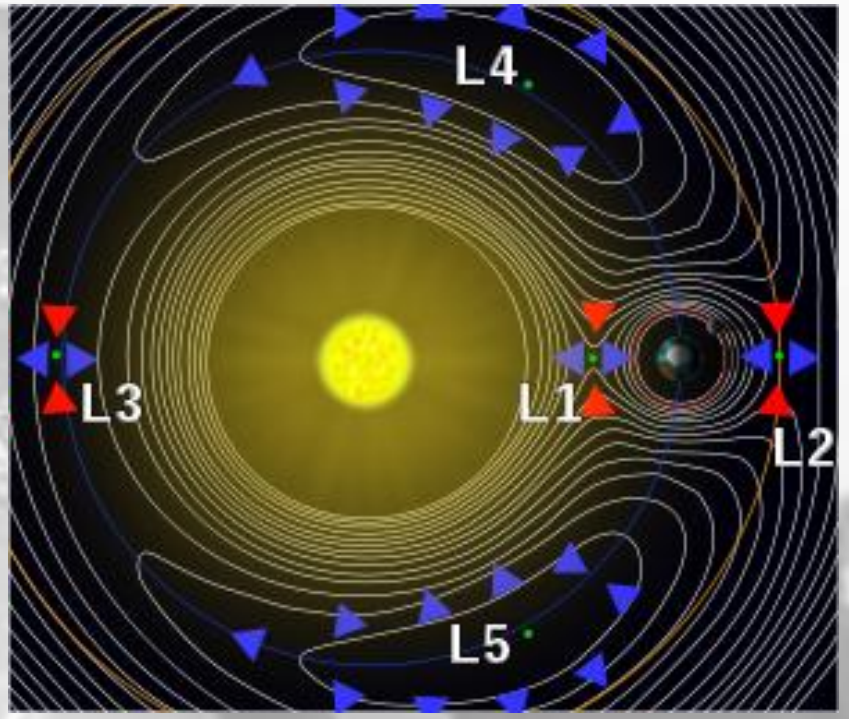




A bit of history

Those solutions were later seen to explain what are now known as the Lagrangian points.

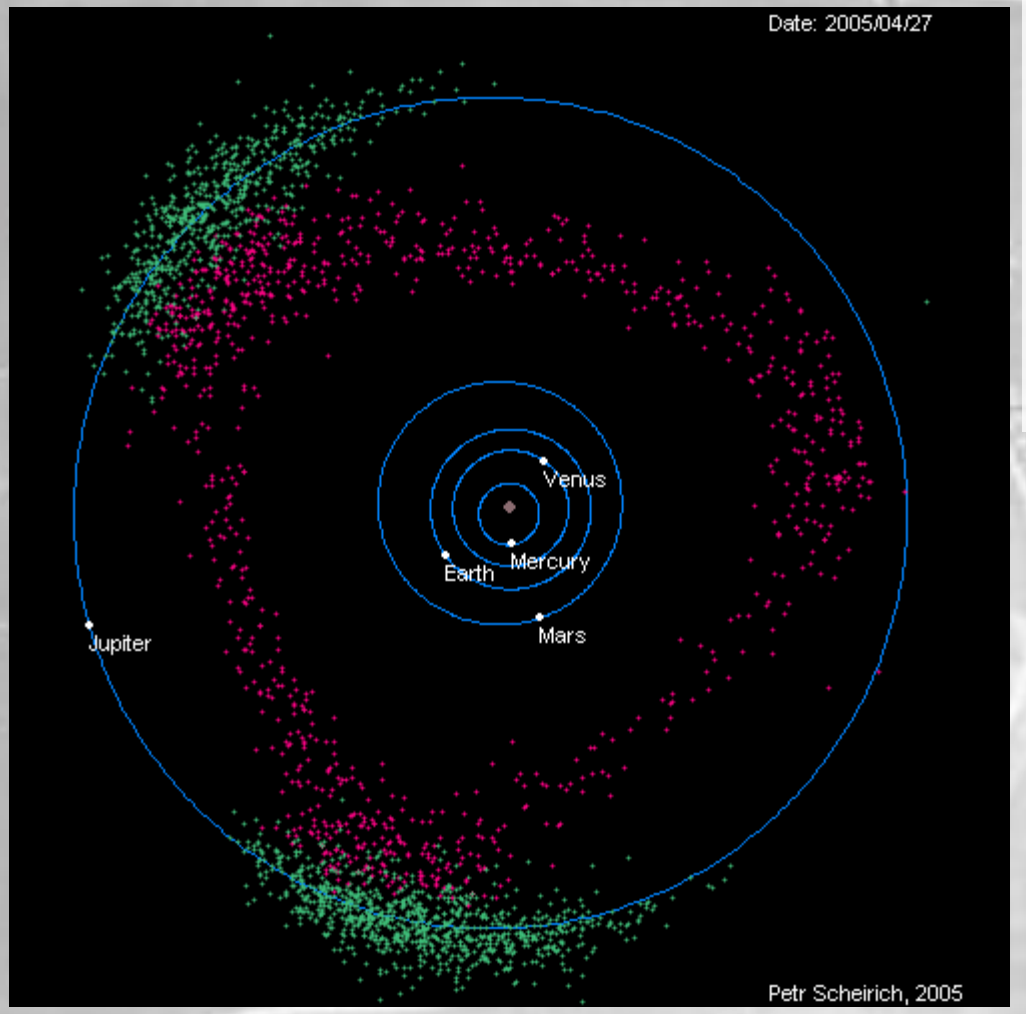




In the rotating system of two bodies, there are five points of equilibrium.

The body of a very low mass is stable at such point.

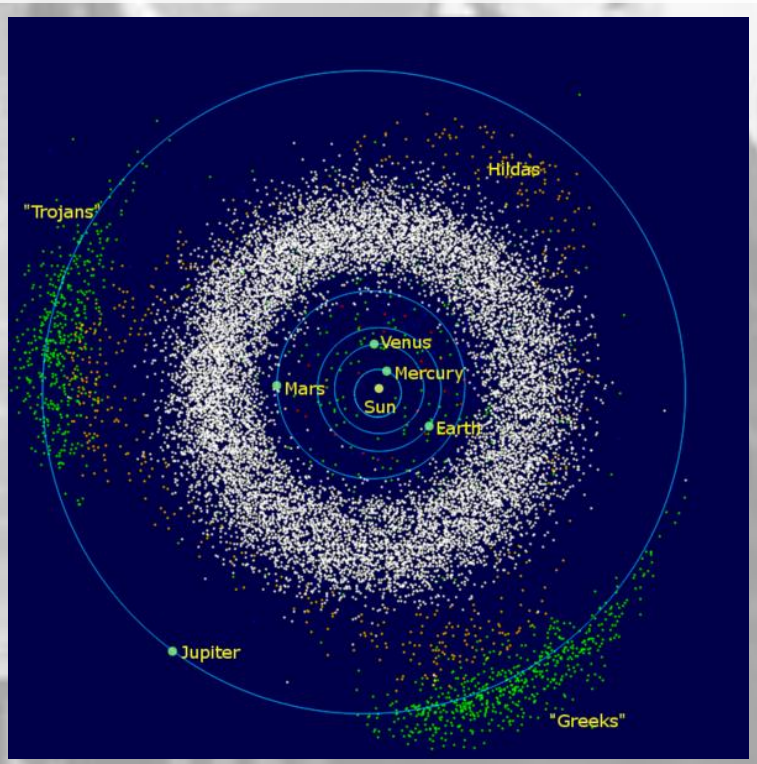
A bit of history



In 1906, Max Wolf discovered asteroid 588 Achilles stable object in Lagrangian L4 point.

Currently, we know more than 4500

Similar objects found in the system of the Sun and: Mars – 4, Saturn – 4, Neptune - 7



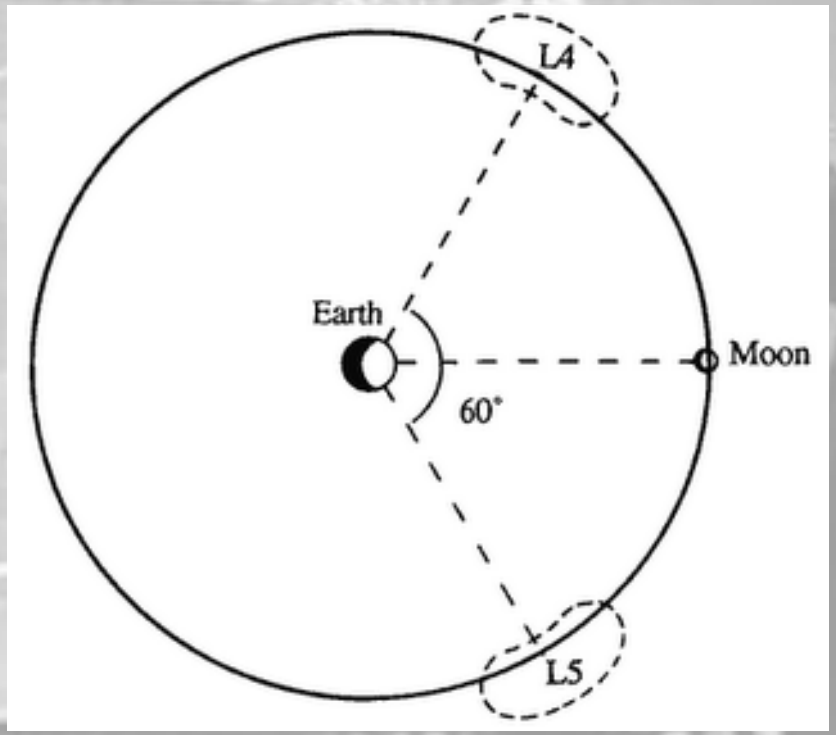
The conception

Tadeusz Banachiewicz

Kazimierz Kordylewski

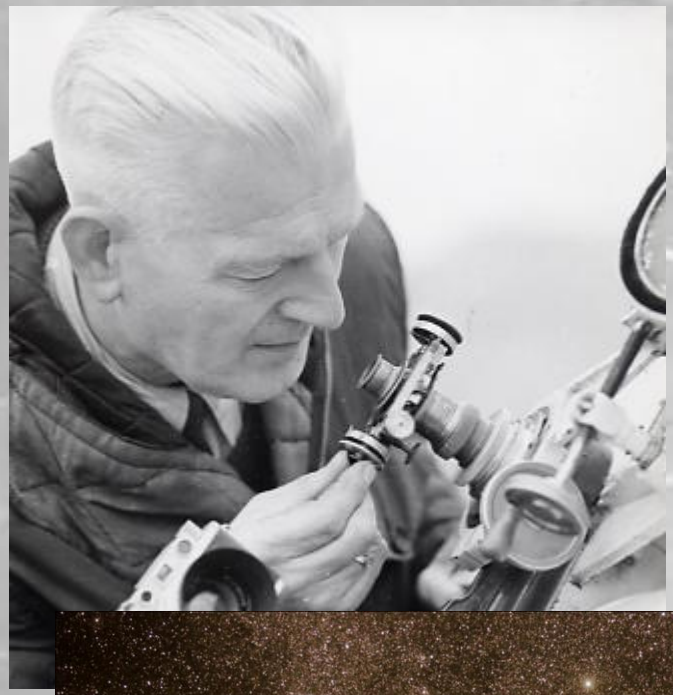
In 1951 prof. Banachiewicz ordered to develop a program observation utilizing unused double astrograph.

The program was developed by Dr. Kazimierz Kordylewski. He wanted to look for objects in Lagrangian points of the Earth – Moon system



Kordylewski expected that hypothetical objects should have
a brightness about 12 mag.

The conception

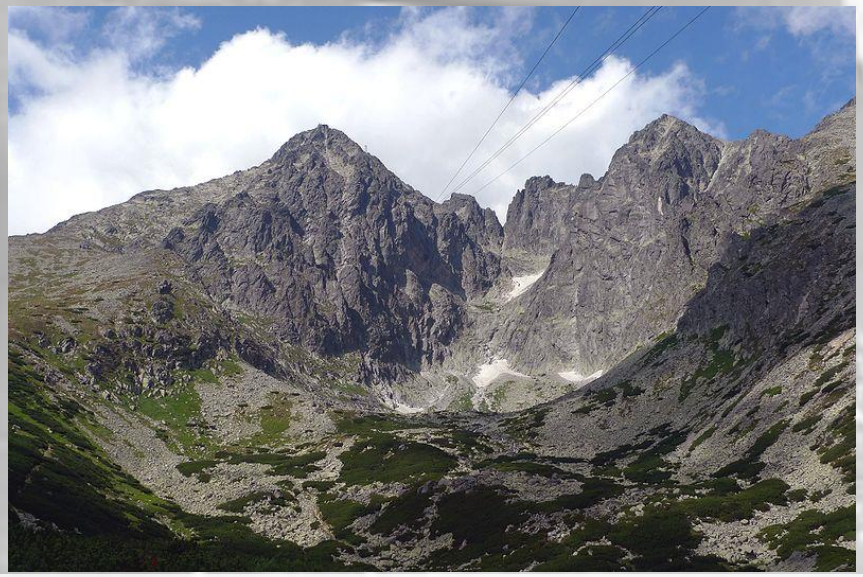


Kordylewski did not find the desired object, but prof. Witkowski suggested that in the Earth-Moon system only dust may be gravitationaly bound.

Kordylewski began to make photographs of selected areas of the sky with the camera with a bright lens, but he was defeated again.

He decided to start visual observations.

The discovery



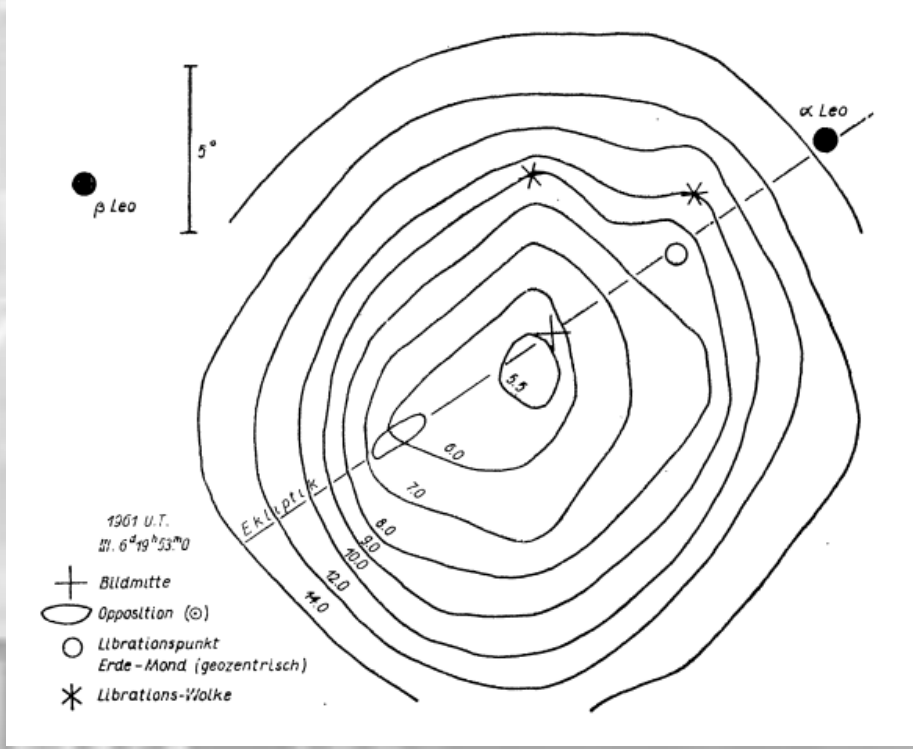
Observations were carried out in high Tatra at the tops of Łomnica (2634 m) and Kasprowy Wierch (1987 m)

The first observation - October 1956. Two days later, Dr. Kordylewski observed cloud again and concluded that shift of cloud is consistent with movement of the Moon.

In 1961 (March and April) the photographs were taken – Kordylewski was ready to publish his results

Acta Astronomica Vol. 11 (1961) No 3

Photographische Untersuchungen des Librationspunktes L5 im System Erde-Mond



Doubts and confirmation

Many observers trying to repeat observations but failed.

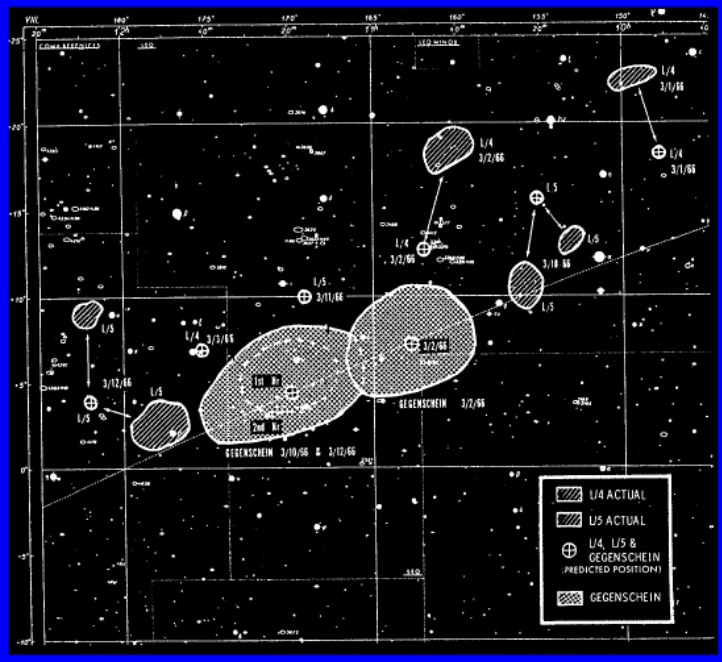
For Kordylewski it is not surprising simply because it is a difficult task that took him 10 years of hard work ...

But finally…

First confirmation came

LIBRATION CLOUDS and gegenschein as observed from an altitude of 12 000 meters in March 1966. The background is a standard star map. Predicted locations are indicated by a cross in a circle labeled with the name of the object and the date it was expected there. Shapes and positions of the observed libration clouds are shown by diagonal shading; the gegenschein is indicated by cross hatching.

J. Wesley Simpson is founder and director of the Locksley Observatory of Lockheed Missiles & Space Co.



Simpson 1967

Properties

Reference	Date	Technique	Magnitude (arcsec^{-2})	Cloud size	Number density enhancement	Col. density (cm^{-2})
Grün *et al.* 1985			-	5°	-	~10^{-3}
Kordylewski 1961	March - April 1961	Photographic (35mm film, 50mm focal length, f/1.5, 12 min. exp.)	22	5°	1.2 x 10^{5}	2.0 x 10^{2}
Simpson 1967	January 1964 February 1966 March 1966	Visual Photographic (4-8 min exp.) Visual (airborne)	20.5	4°	6.0 x 10^{5}	6.8 x 10^{2}
Vanysek 1969	March 1966	Visual (airborne)	22.6	4°	8.9 x 10^{4}	1.0 x 10^{2}
Roosen 1968	March 1966 March 1967	Photographic (35mm film, 50mm focal length, f/1.4, 1-9 min. exp.)	fainter than 26	<2°	<8.0 x 10^{3}	<5.4
Wolff *et al.* 1967	March 1967	Photographic (airborne, 35mm film, 50mm focal length, f/1.4, 20-40 min. exp.)	fainter than 25.4	<2°	<1.4 x 10^{4}	<9.2
Roach 1975	Autumn 1969 to Winter 1970	Photometric: Rutgers Zodiacal Light Analyser on OSO-6	24.5	6°	1.0 x 10^{4}	21
Schlosser *et al.* 1975	March to April 1971	Photographic: using wide angle (140°) photographs.	fainter than 26.6	<7°	<1.3 x 10^{3}	<3.1
Munro *et al.* 1975	July to December 1973	Photometric (white light coronograph on Skylab)	fainter than 16.7	<5°	<1.2 x 10^{3}	<1.0
Winiarski 1989	February 1976	Photographic: various techniques	23.8		2.2x10^{4}	30

Moeed i Zanecki 1997

Let us try!

More than 50 years after the first observation the existence is still disputed by some researchers.

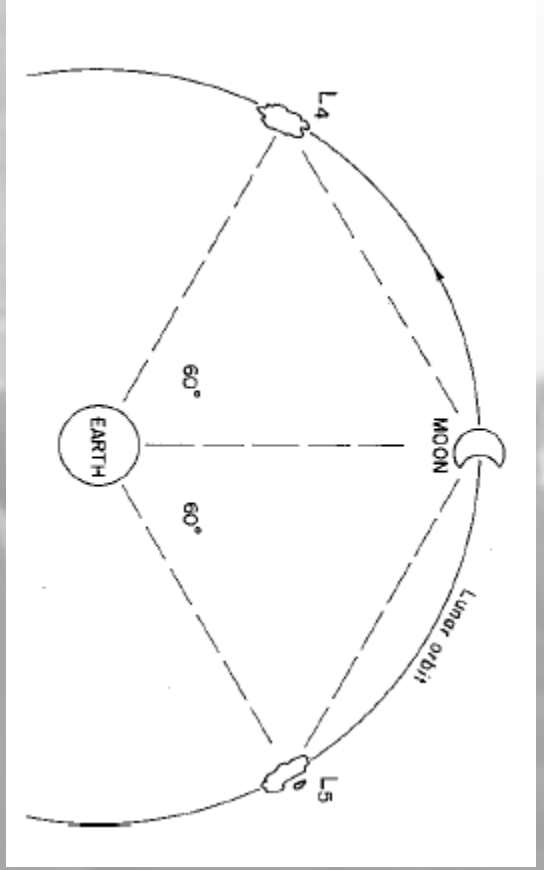
Nevertheless, the problem is waiting for a solution.

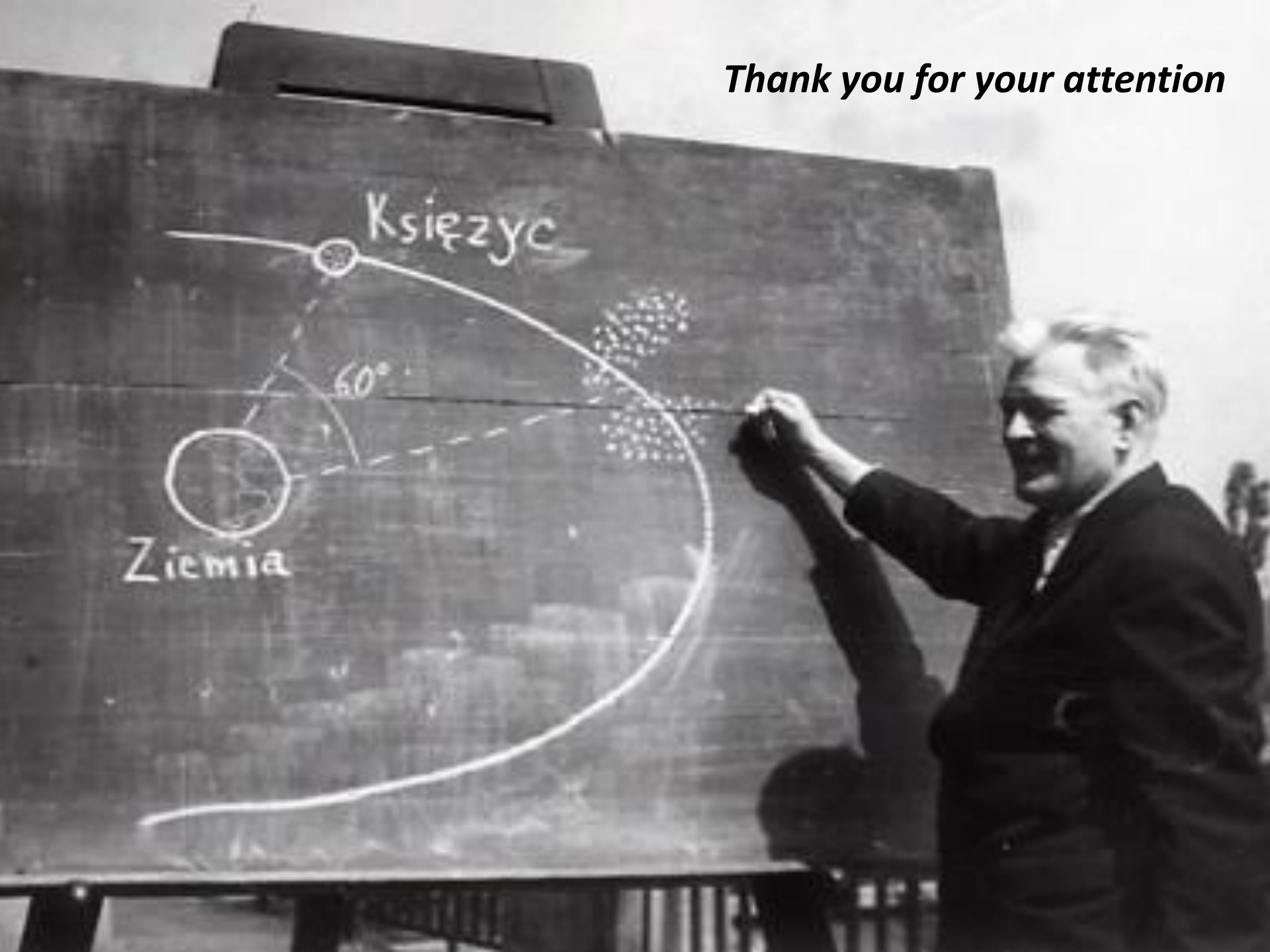
This could be a interesting problem for amateur astronomers under the darkest sky

Let us try!

Laufer R. et al. 2010, THE KORDYLEWSKY CLOUDS – AN EXAMPLE FOR A CRUISE PHASE OBSERVATION DURING THE LUNAR MISSION BW1:

- the libration clouds are about 6 degrees in angular size as seen from the Earth,
- they move around the libration point, over an elliptical zone with a semi-major axis of about 6 degrees along the ecliptic and a semi-minor axis of about 2 degrees perpendicular to the ecliptic,
- the libration clouds are closer to the Moon during the northern summer months, and away from the Moon during the northern winter months with respect to the Lagrangian point,
- brightness is about half the brightness of the counterglow,
- color is much redder than the counterglow,
- this might indicate that the particles are of a different nature as in the counterglow.
- they are transient events…





Thank you for your attention