

# Some Historical and Mythical Aspects of the Discovery of the Solar Corona

**Serge Koutchmy**  
Institut d'Astrophysique de Paris  
CNRS & UPMC (France)

**Today, the solar corona is continuously analysed:  
Several space missions are involved  
(SoHO, Trace, Coronas, and others).  
In the very near future several missions  
will permanently analyse the corona in 3D:  
Solar-B; Stereo; Coronas-Ph.; Inter-Helios; Solar-Orbiter..  
(also: Ground-based Solar Observatories)**

**Coronal studies are now organized with great accuracy  
and have become part of Space Weather studies.**

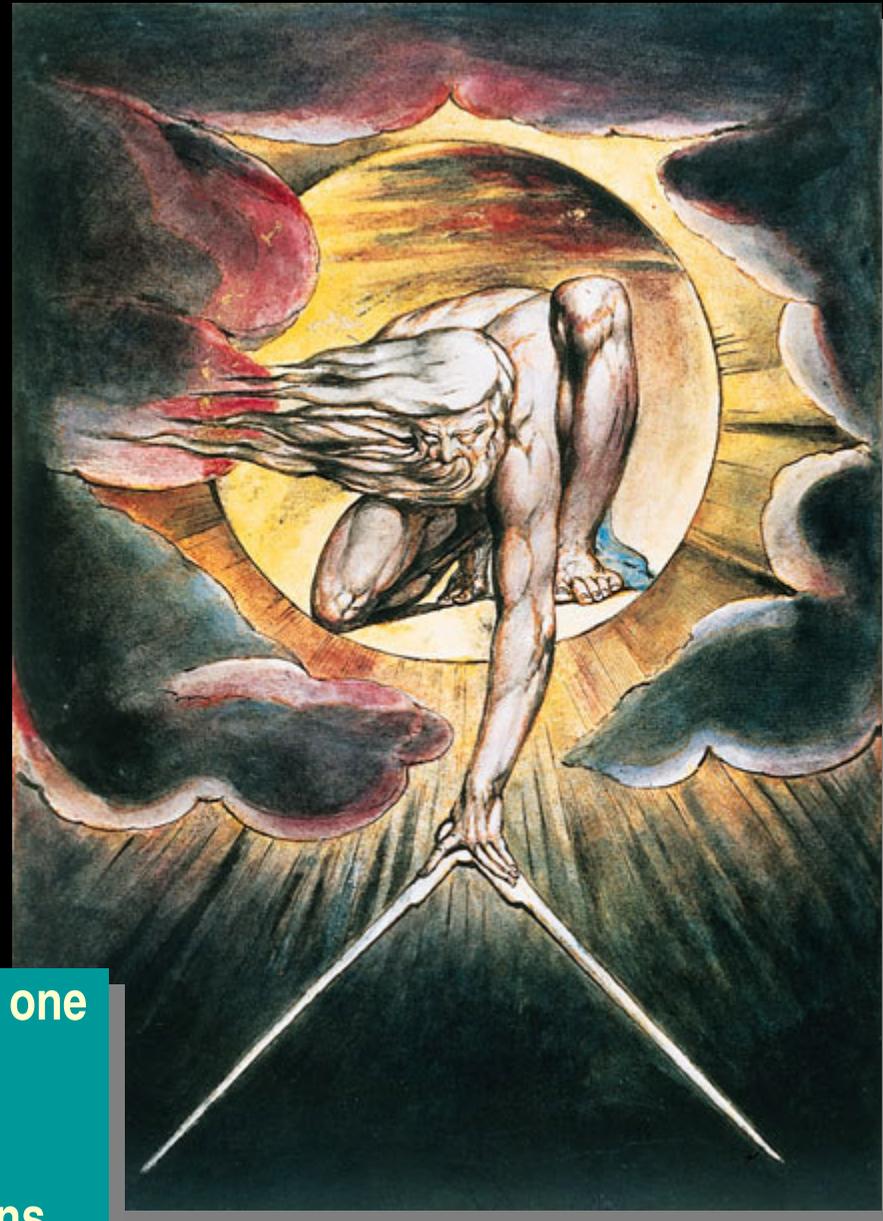
**But When, How and Why did Humanity  
discover this fundamental phenomenon ??**

# The Sun as a symbol and as an actor in Antiquity and today...

## Consequences:

- Myths (Earth ; Atmosphere ;...)
- Religions (Gods ; Human being ;...)
- Civilizations; traditions...

The Creation  
W. Blake (1796)



In search of understanding, man found in one

*Creator*

his religions and the source of his origins.

## Akhénaton (Aménophis IV)

v. 1350 av. J.-C. (Le Caire) Aton

In ancient Egypt, the solar disk was proposed as a single divinity (pre-monotheism)

13/04/2006



## A « NASA » image; Solar-Terrestrial relations

Modern man still considers  
the Sun as having the same  
« magical » influence as  
3000 years ago.

But what about its corona ??





Scarab and the « winged »  
Sun: symbol of the daily  
rebirth of the Sun.

Egypt ca. 1330 B.J.-C.

13/04/2006

# Origin of the myth of the « winged » Sun ?

## Was the corona discovered during a total eclipse of the Sun ?

Supernatural interpretations are present in various civilizations: Egyptians, initially; Assyrians; Chinese; Indonesiens; Incas; etc. etc.

**At least 1400 years B. J.-C.**

Egypte ancienne  
Wood  
Louvre

The « winged »  
Sun-disk

13/04/2006



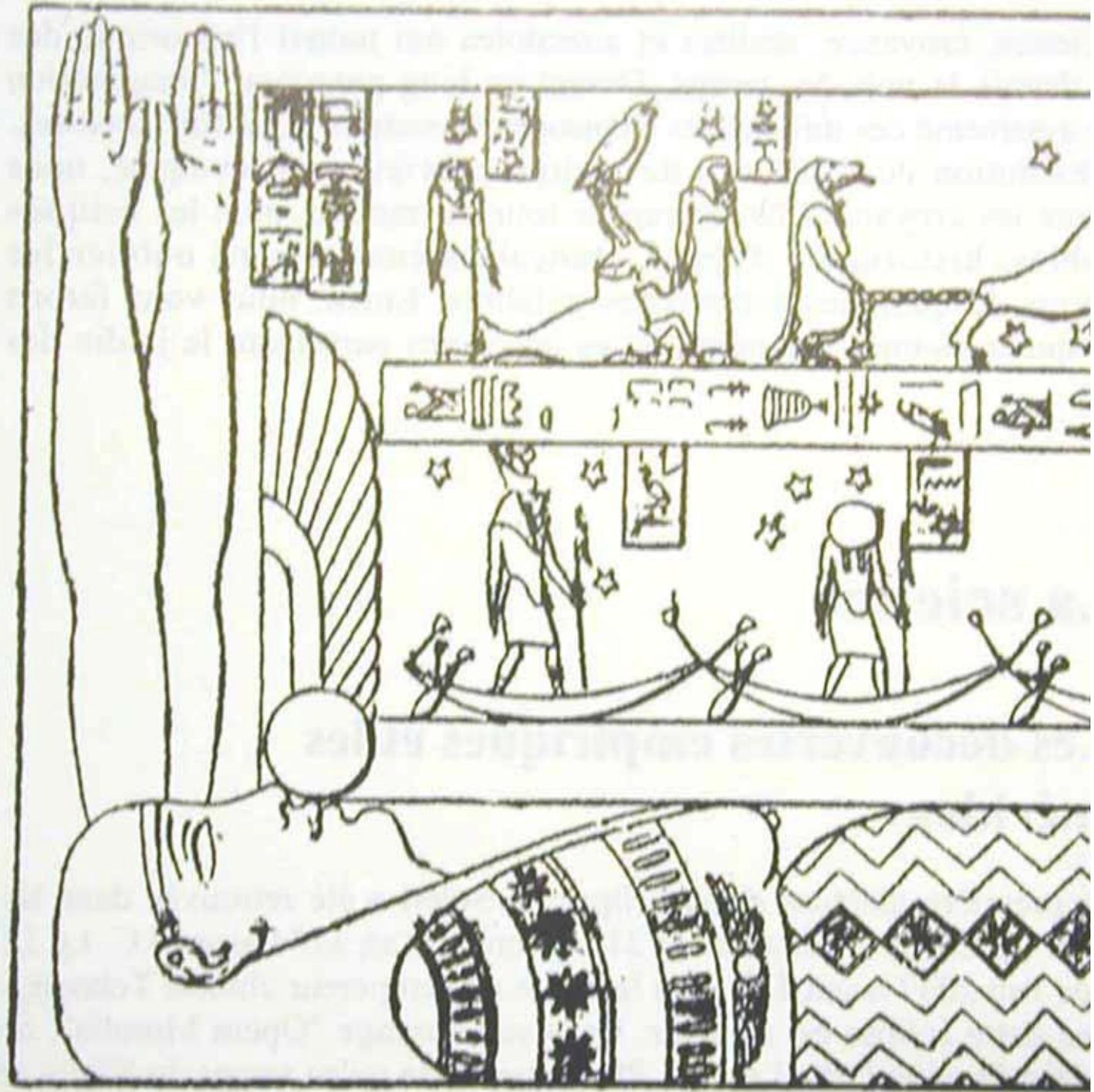
Egypte Ancienne  
Bois  
Louvre

# Southern ceiling- Temple of Thèbes



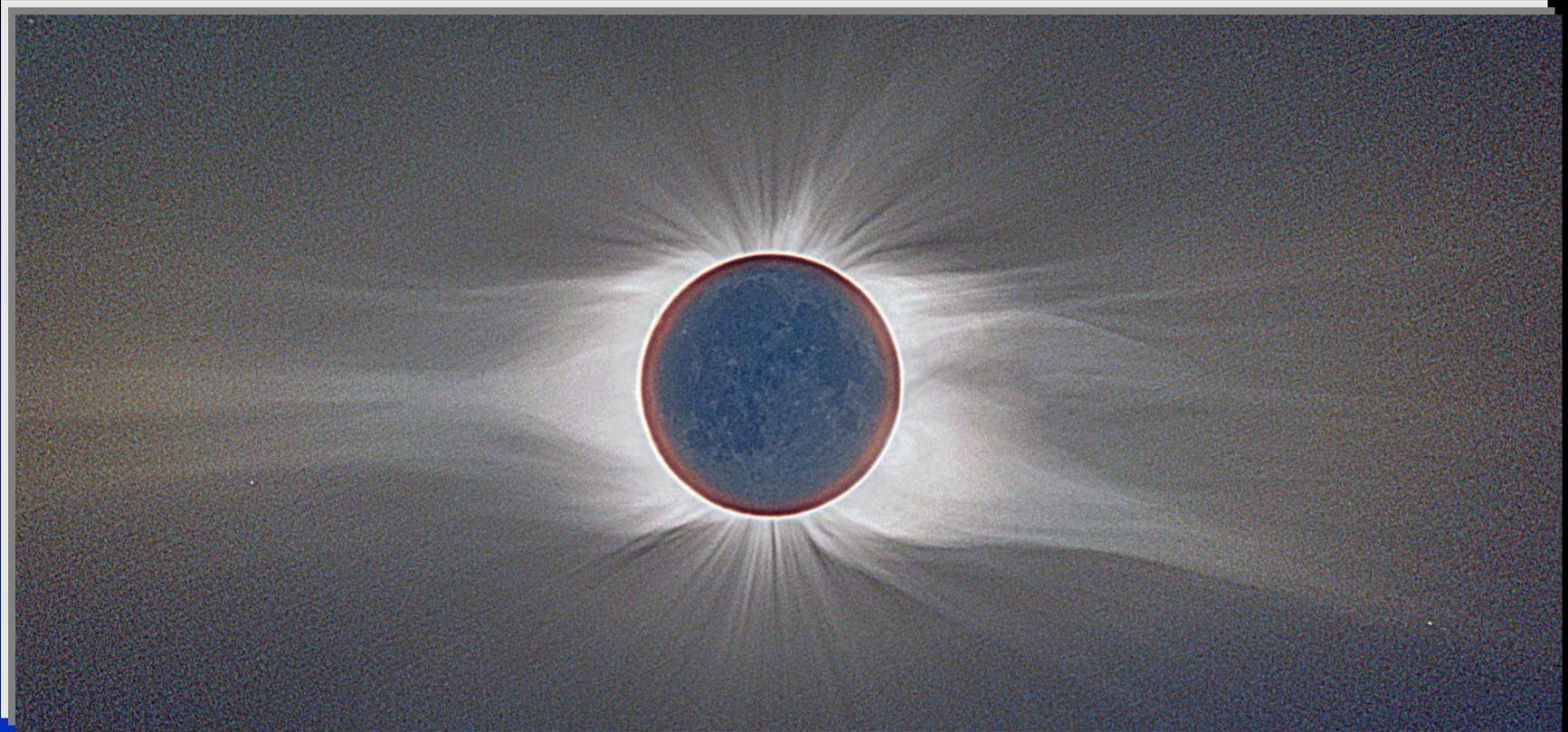
**A.T. Moreux**  
**Gravure**

The winged Sun is a recurrent theme in the vestiges of many civilisations.



**Modern image of the solar corona**

**@ Chr. Viladrich, 1998**



**But is it the true corona that is being understood ??**

13/04/2006

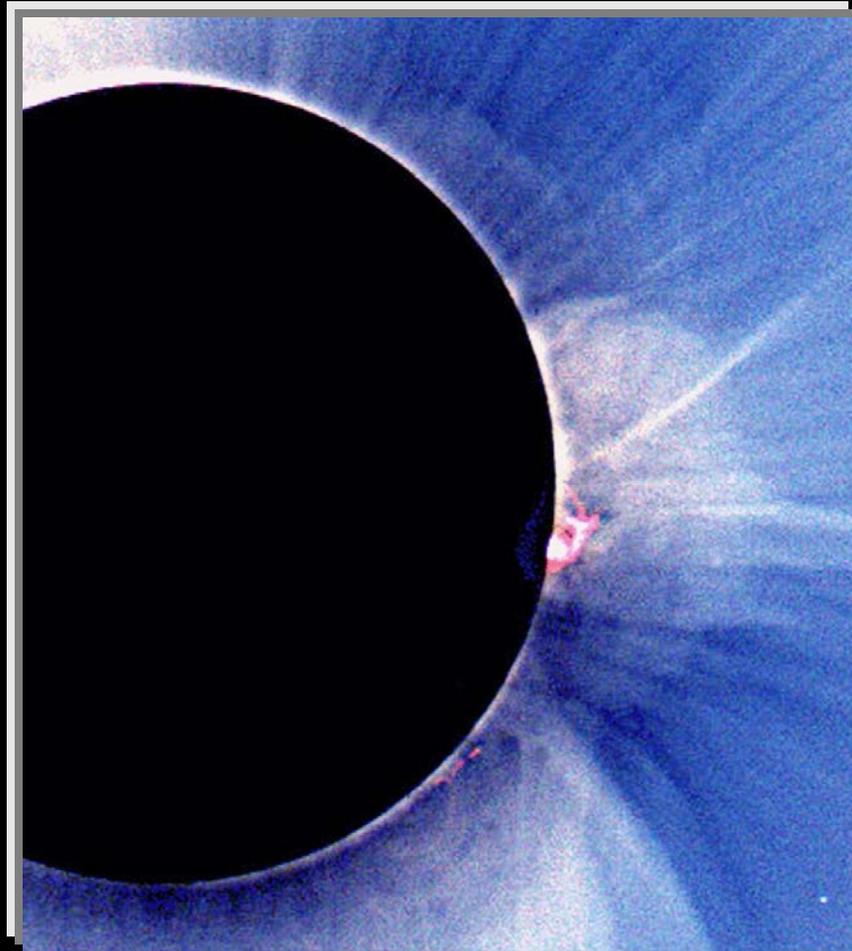
12

Here the solar disk was represented with an edging and the head of a cobra which could describe what is seen in an annular/total eclipse.

Le serpent (qui se mord la queue) est le symbole souvent « utilisé » pour exprimer la notion de temps...



**The Western limb of the  
Eclipse Corona of July 11,  
1991**

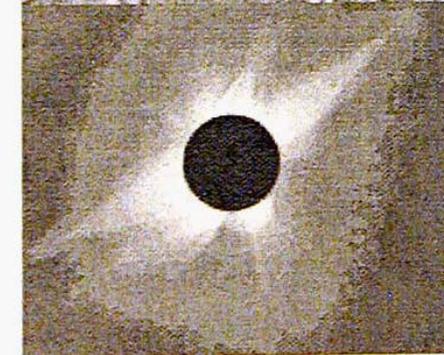


13/04/2006

## Symbols in Assyria, image of the corona and American Phoenix

The symbol of the obscured and winged Sun is found in many vestiges of famous civilizations: perhaps this is indeed the solar corona with its large streamers, its prominences and polar plumes observed at total eclipses ?

(a thesis by E.W. Maunder, 1883, and again by Robin Edgar, 2000)



# The solar corona is then « forgotten » for 2000 Years...

Possible reasons:

- Incompatibility with cosmogony and religion (biblical beliefs);
- Geocentric Model of the Universe (C. Ptolémée);
- Astrology which allots to planets a dominant role in human destiny.

**Up to at least 1600 A.J.-C.**

Cathedral of  
Padoue  
XIVth century

After Aristarchus of Samos  
(-290) and  
Plutarch (-50), triumph of the  
philosophy of  
Plato (-370) and especially of  
Aristotle (-350);

model of C. Ptolemy (140);  
founding of the biblical  
cosmogony; birth of the  
medieval astrology...





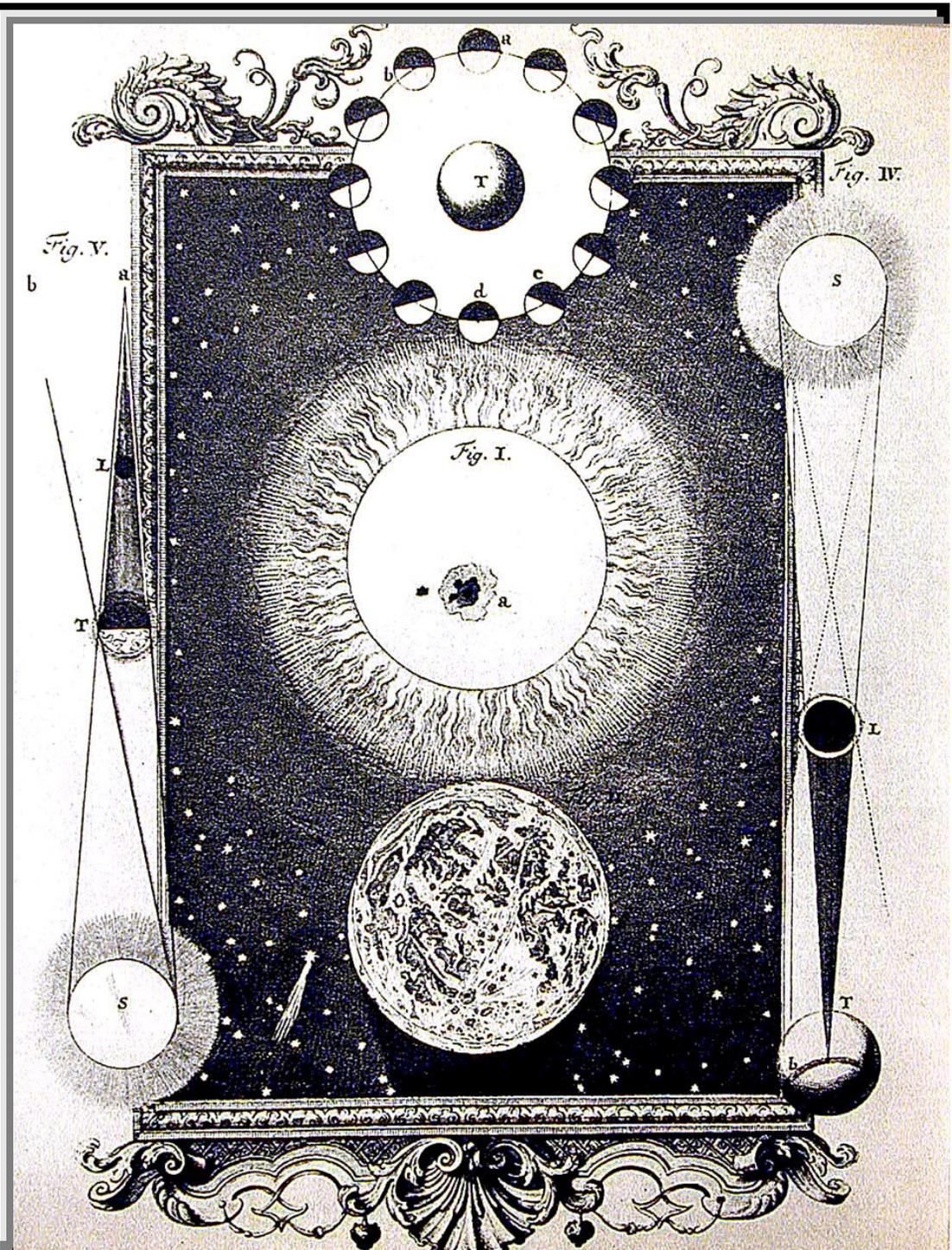
# End of 15th and 16th centuries: a new era starts

with the great « discoveries »; then N. Copernicus who « rediscovers » the héliocentric cosmogony. Its model (1543) is improved by Képler (1600) , following Tycho Brahe and others.

The true nature of planets and satellites, of the Sun and the Moon, is revealed thanks to the observations of Galileo (1610)... Then it is the triumph of celestial mechanics with Newton(1700), then Laplace (1800) and many others.

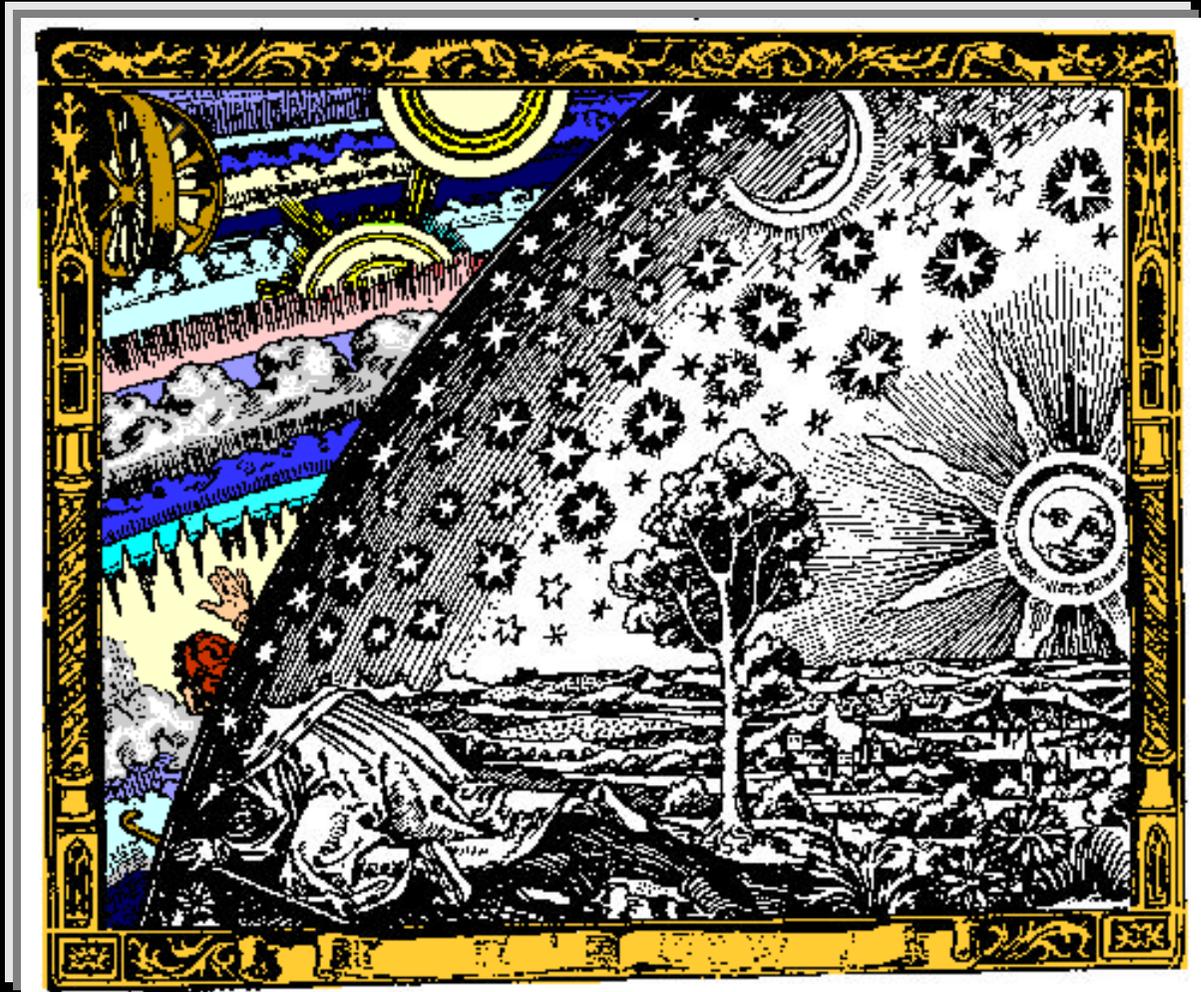
13/04/2006

18 ème siècle



The Universe opens to the curiosity of the man;  
end of the Middle Ages ...?!

Gravure from a  
well-known  
book by C.  
Flammarion  
(19th century)

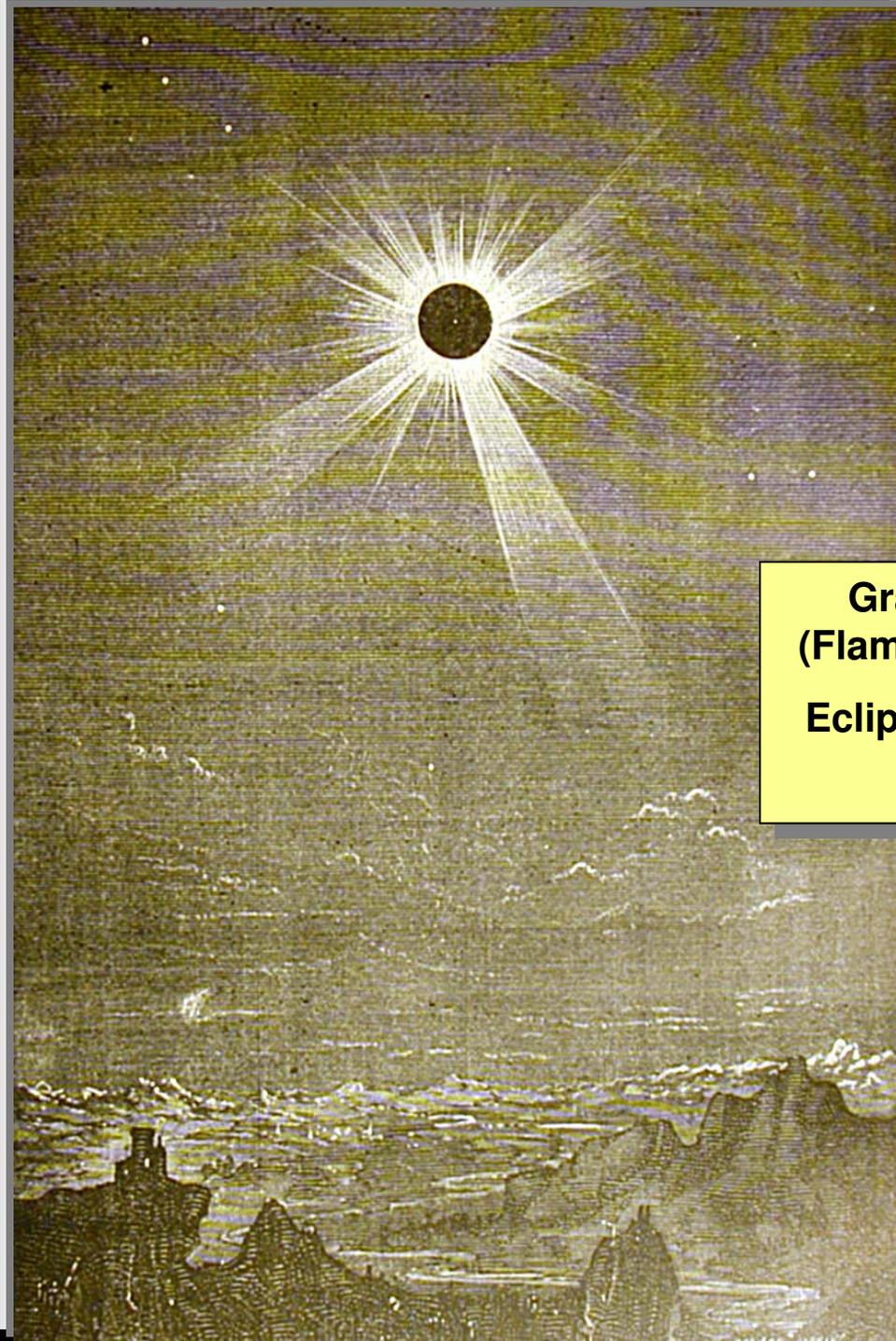


# A « revealed » corona

- Eclipses are predicted with precision (charts);
- But errors in interpreting the aureole observed during totality;
- First steps in realizing the existence of a solar corona and its influence :
  - Comets ;
  - Auroras ;
  - Terrestrial magnetism

< 1900

The aureole appearing during the totality of eclipses is wrongly interpreted: Kepler was the 1st to suggest effects due an atmosphere surrounding the Moon; Halley « confirms » using micrometric measurements of the aureole during the 1715 eclipse. Arago proposed, just before the eclipse of 1842, to call it « the lunar corona » but this suggestion is quickly abandoned after the eclipse.



Gravure  
(Flammarion)  
Eclipse 1878

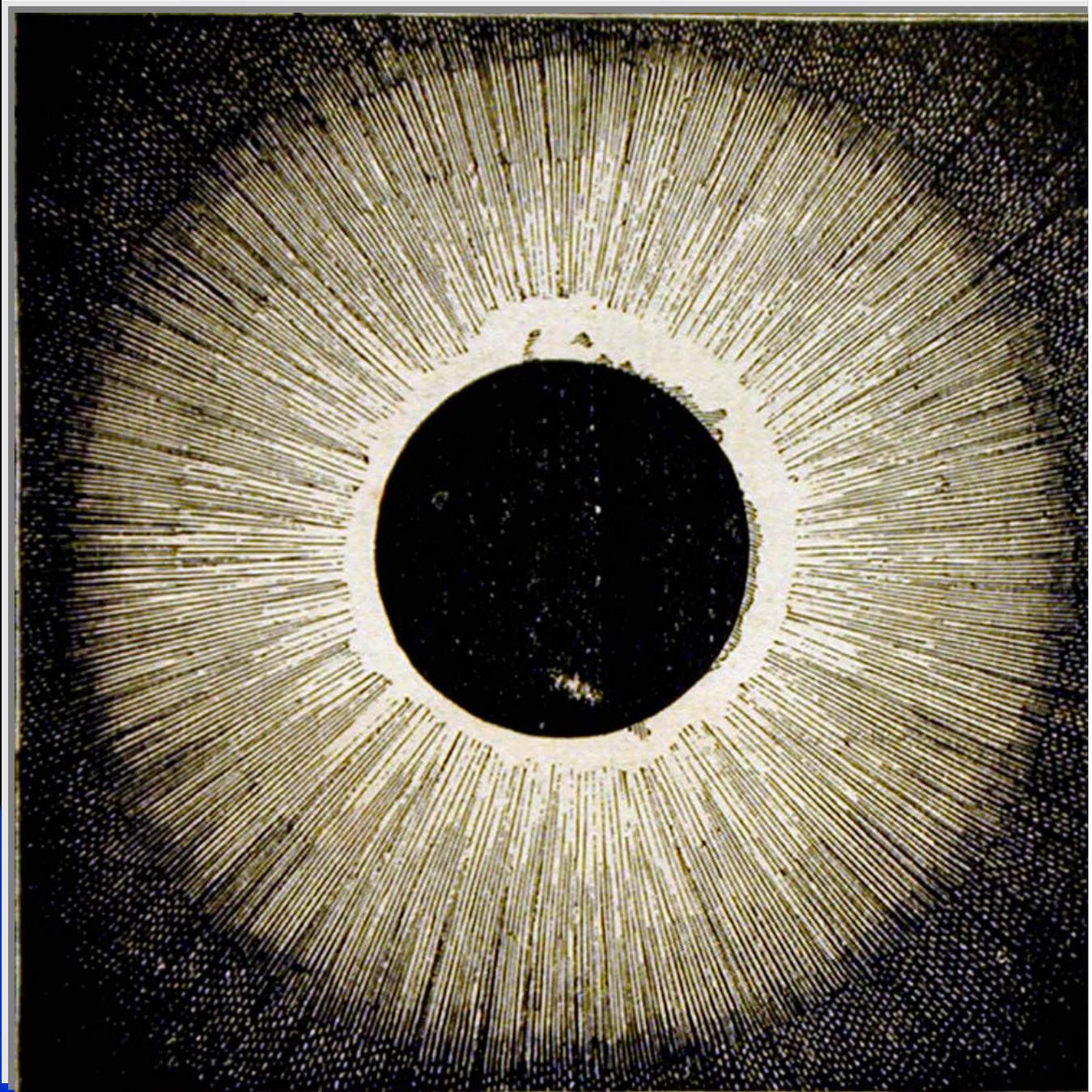
## Secchi

Eclipse of 1851

The corona is thought to be the result of diffraction effects on the edges of the Moon !

Or possibly due to some refraction effect in the Earth's atmosphere

13/04/2006





**Optical effect observed in  
the Earth's atmosphere  
after a sunset**

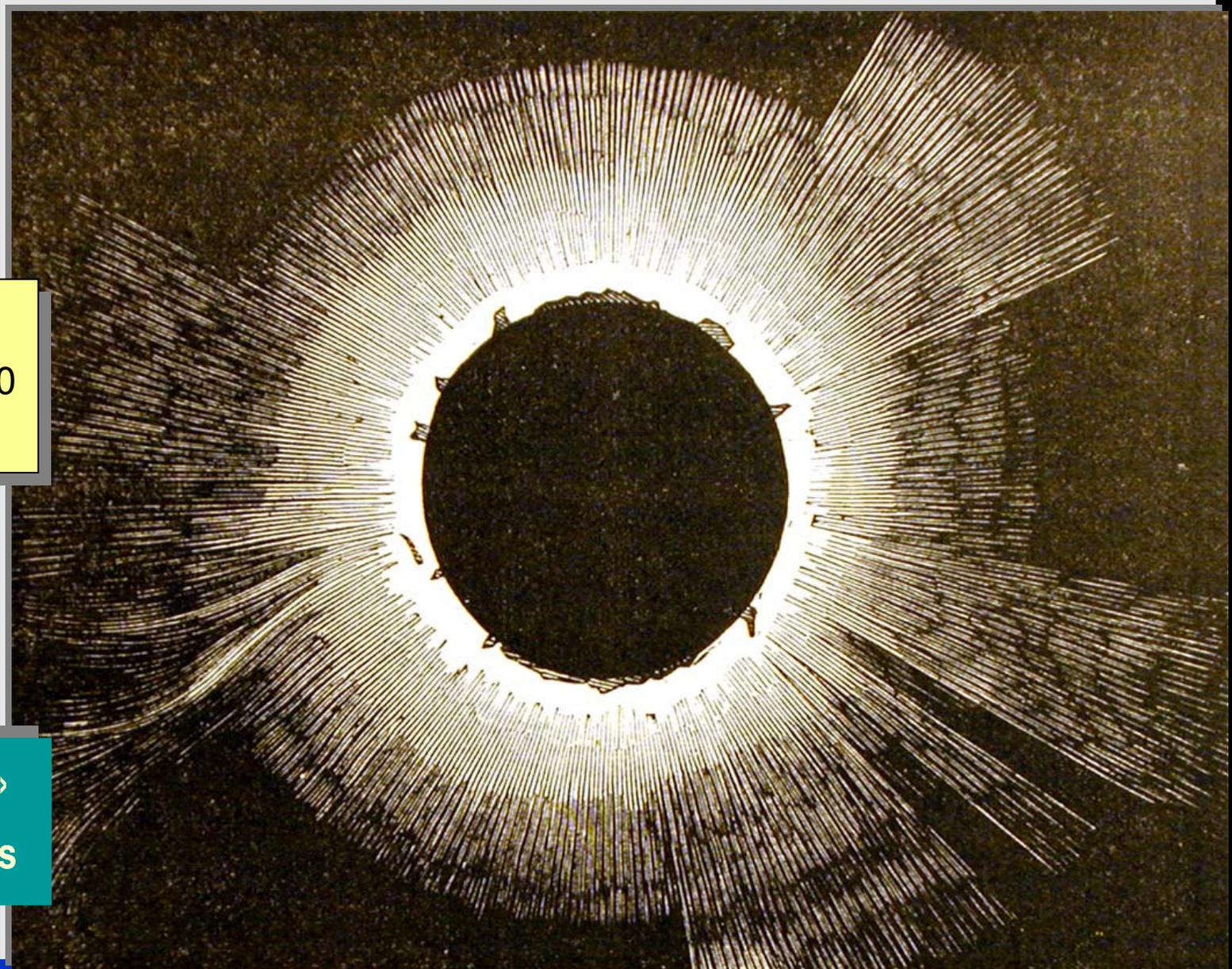
13/04/2006

24

**Secchi**

Eclipse of 1860

« Aigrettes »  
and  
prominences

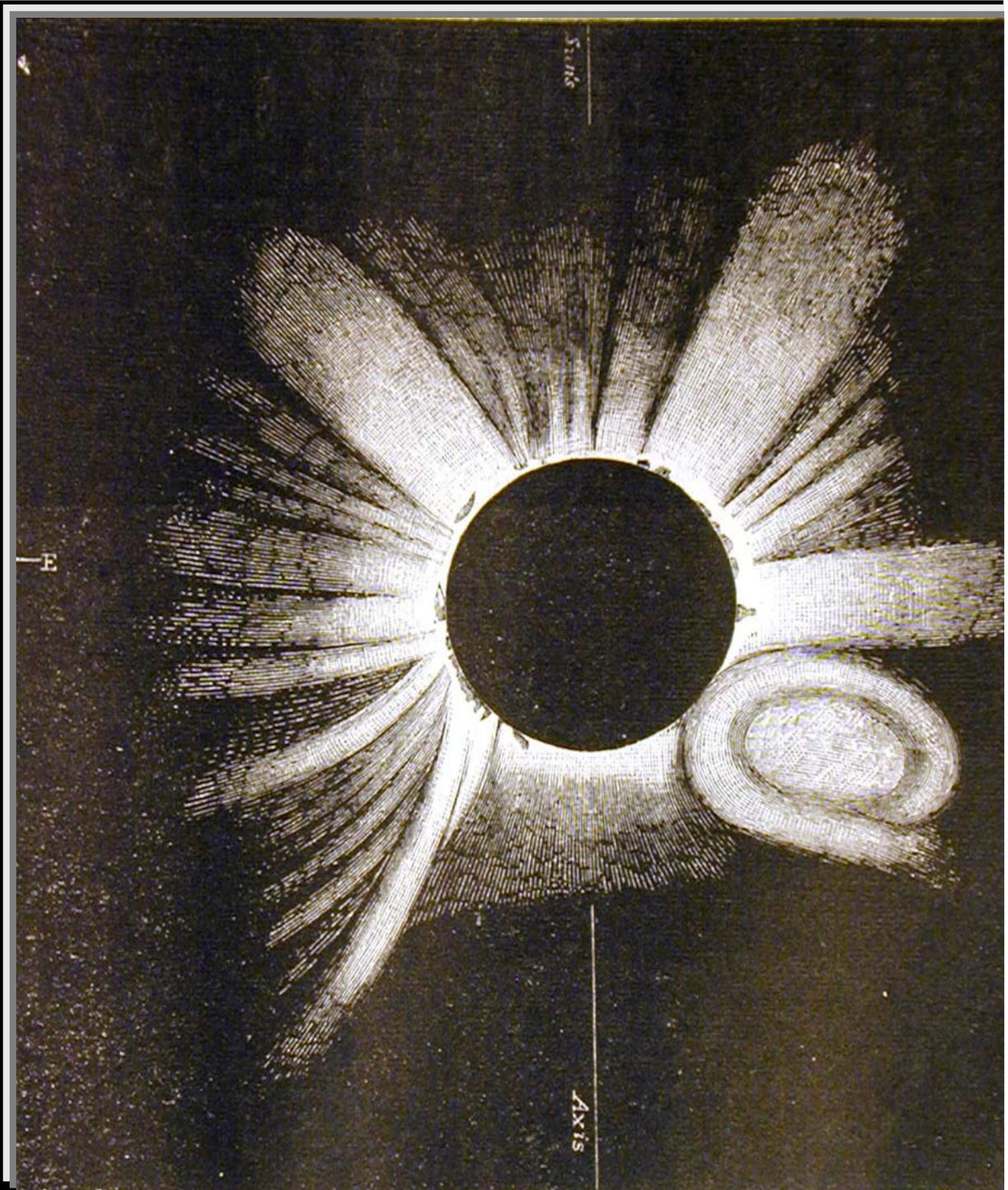


**Tempel**

Eclipse of 1860

Here is the same corona as before ! It is indeed the 1st observation of a CME....  
Liais already had drawn the structures of the corona of 1858 and had brought back the 1st measurements of the polarization of its light as predicted by Arago...

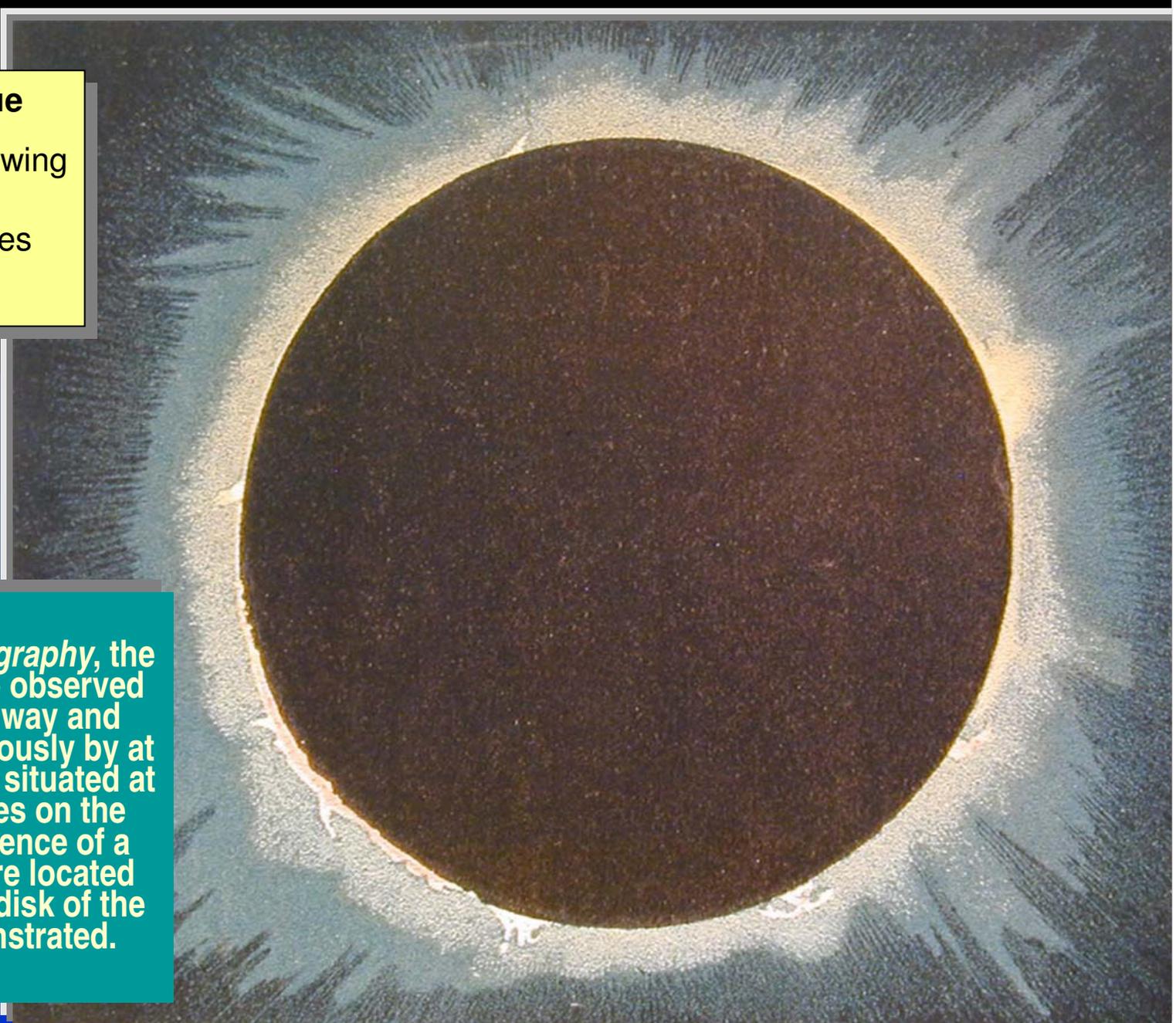
13/04/2006



**Warren de la Rue**

Eclipse of 1860, drawing  
after the 1st  
photographic plates

Thanks to *photography*, the prominences are observed in an objective way and almost simultaneously by at least 2 observers situated at 2 different places on the Earth. The existence of a solar atmosphere located well beyond the disk of the Moon is demonstrated.



Thanks to photometric and to polarimetric work, the objective existence of a solar corona seems established (about 1870). Nevertheless in his book on the Sun, written in 1883, p. 179, A.C.

Young wrote about the corona at eclipses:

« ...is this a phenomenon of the Sun, the Moon or of our atmosphere, or perhaps a simple optical effect like a rainbow or a halation ? »

However, other observations militated in favour of the existence of an extended atmosphere of the Sun:

- the discovery of the zodiacal cloud;
- the orientation of comet (ionic) tails;
- polar auroras and disturbances of the terrestrial magnetic field...

**Comet Hale-Bopp**

Borrego Desert

4/8/97

www.comet-track.com

The ionic tails of comets in orbit around the Sun always deviate in the direction opposed to the Sun. Bierman much later will propose the *solar wind*.



**Polar auroras had been observed for a long time. De Mairan already proposed in 1733 that they were due to emanations from the Sun of comparable nature to the zodiacal light measured by Cassini in 1683. He suggested for the 1st time a « physical » connection between the Earth and the Sun. Much later, O. K. Birkeland (1895) explained the auroras by the flow of ionized particles coming from the Sun.**

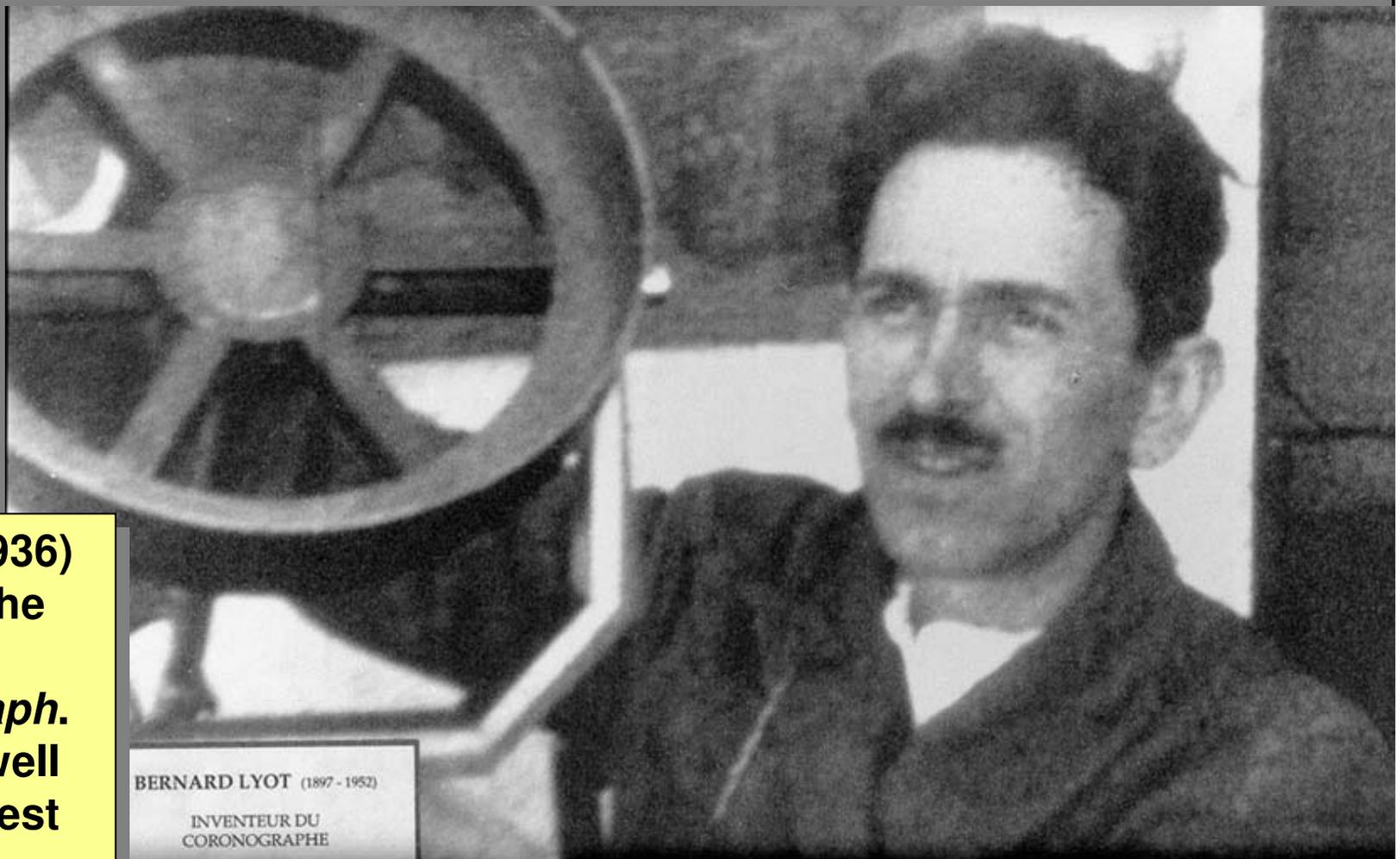


It will be necessary to await progress in *spectroscopy* and the work of Janssen, Lockyer, Rayet and Young (about 1870), so that new diagnostics appear, making it possible to establish the existence of the solar corona: identification of helium; later of coronium...

Nevertheless, even if the chromosphere and prominences are well observed outside of total eclipse, the White-Light corona still remains quit mysterious.

Soon, other nebulas are observed around other stars (Menzel and others).

In 1930, B. Lyot finally invents the coronagraph and definitely shows the solar nature of the corona which now can be studied outside of total eclipse. The emission spectra become reproducible and are studied precisely.



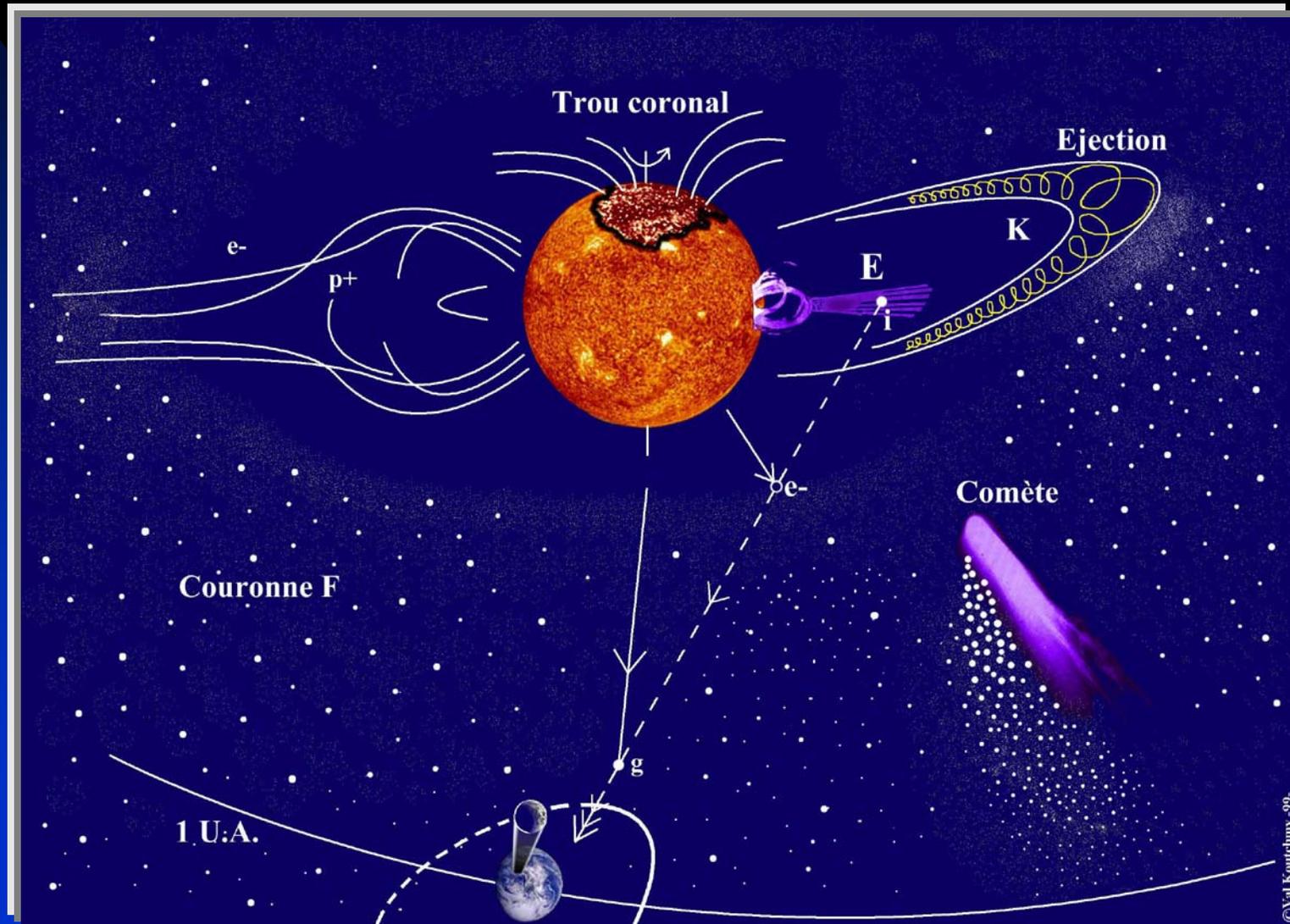
**B. Lyot (1936)  
invents the  
solar  
*coronagraph*.  
He is as well  
the greatest  
french  
astrophysicist  
of the 20th  
century.**

**« Coronium »  
(the Fe XIV  
forbidden line)  
will be identified  
only in 1941, by  
H. Edlen**

13/04/2006

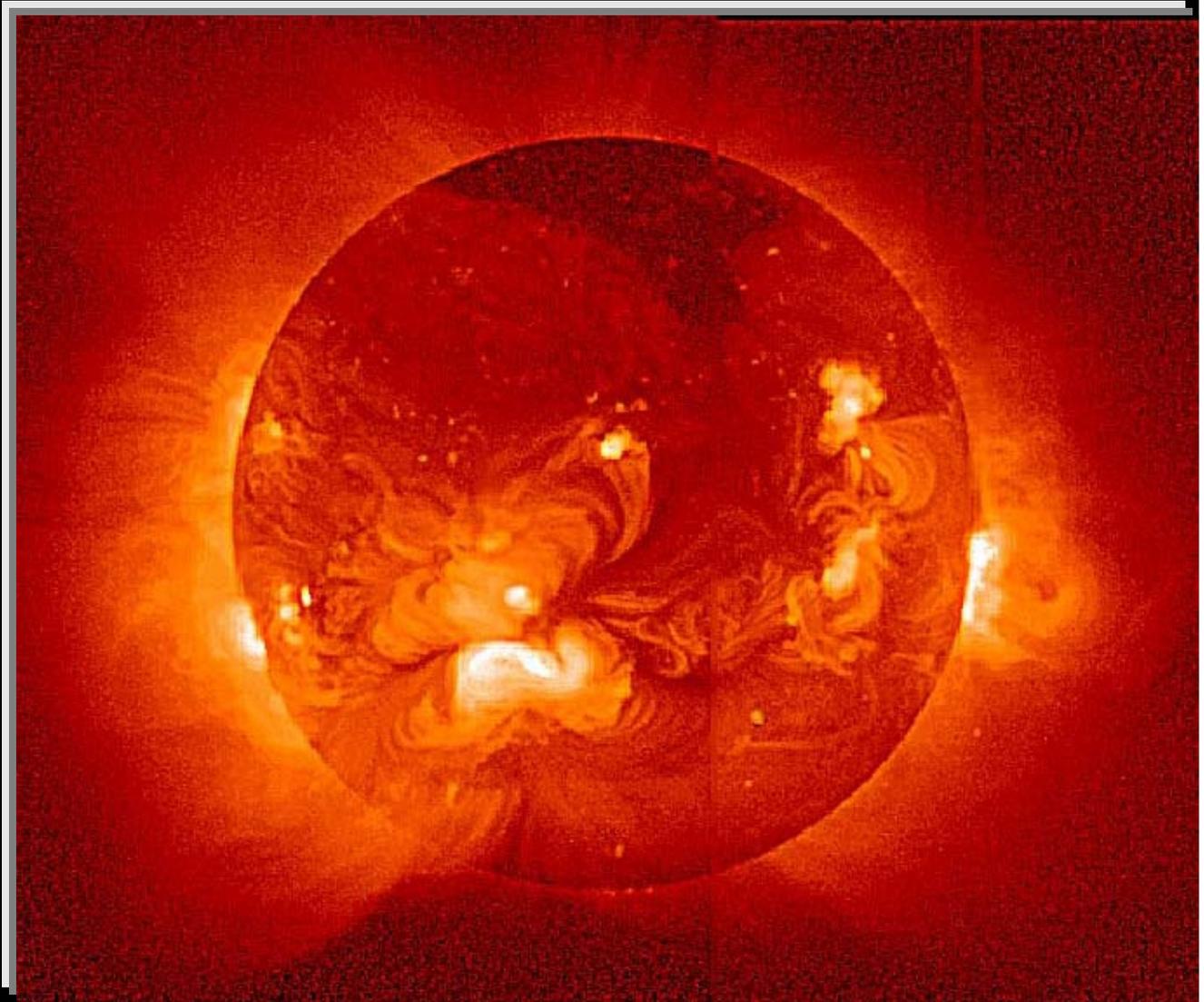
# The Corona and Interplanetary Medium

schematic representation of the phenomena seen during a solar total eclipse



13/04/2006

The SXR *corona* observed in 1992 in space by the Japanese satellite Yohkoh (« the rising Sun ») shows the extraordinary nature of the corona: a plasma at several million kelvin temperature in perpetual renewal. The *origin* of this corona still remains rather mysterious and not established although it is without doubt of magnetic origin.

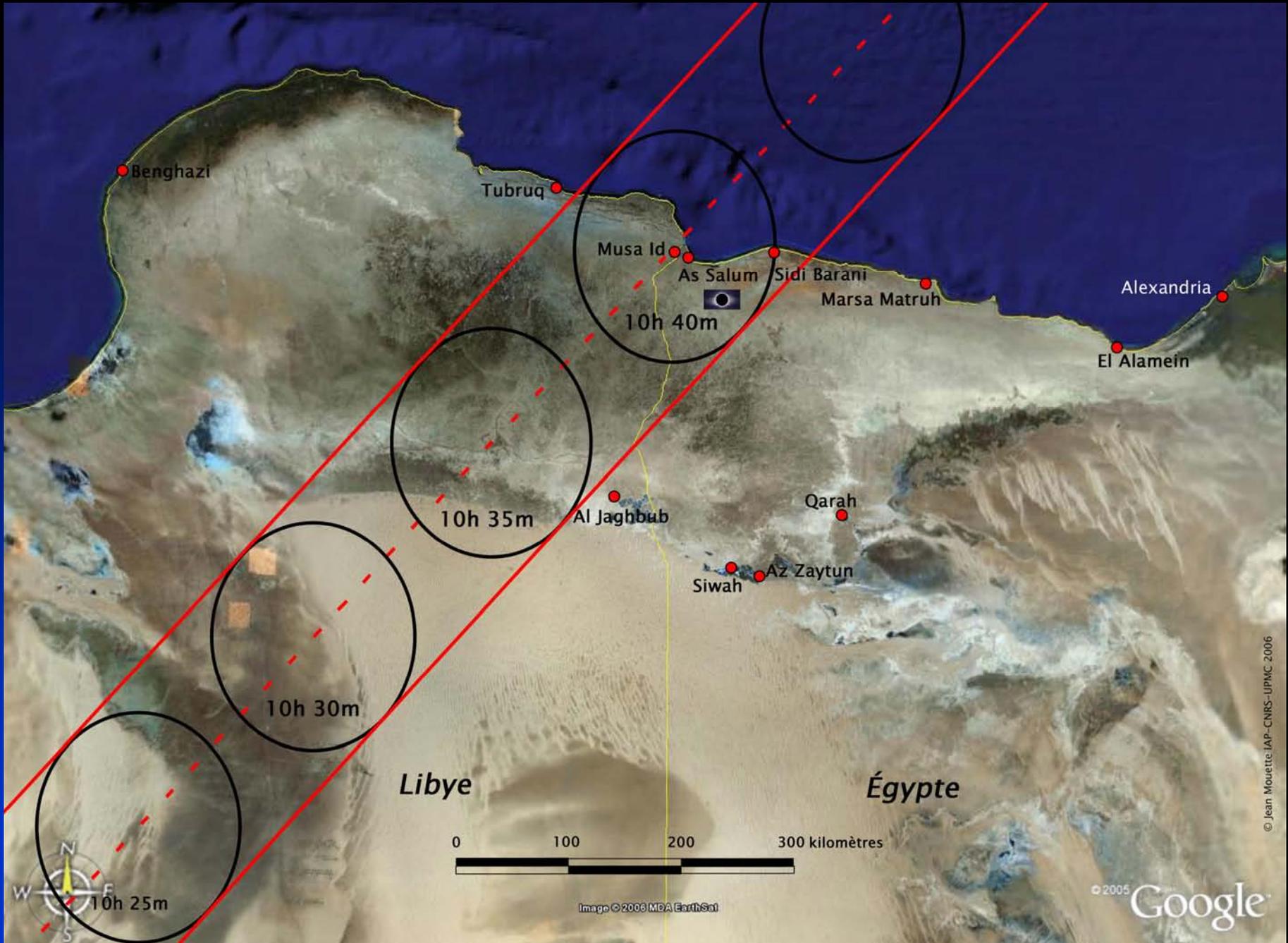


# Conclusions

- One will have needed 3000 years to establish the *existence* of the solar corona.
- How long will it be necessary to understand its *origin* (heating problem) and its *evolution* (winds and loss of mass of the Sun) ?
- This is another story.....

**For the moment, the solar corona can still be accurately observed at the time of solar total eclipses. Soon such eclipse will occur over 4 continents, with rather good observing sites situated in Niger, Lybia, Egypt, Turkey etc. It is a rare (for a single country) but well predicted event. It is a great opportunity to perform scientific astrophysical experiments.**



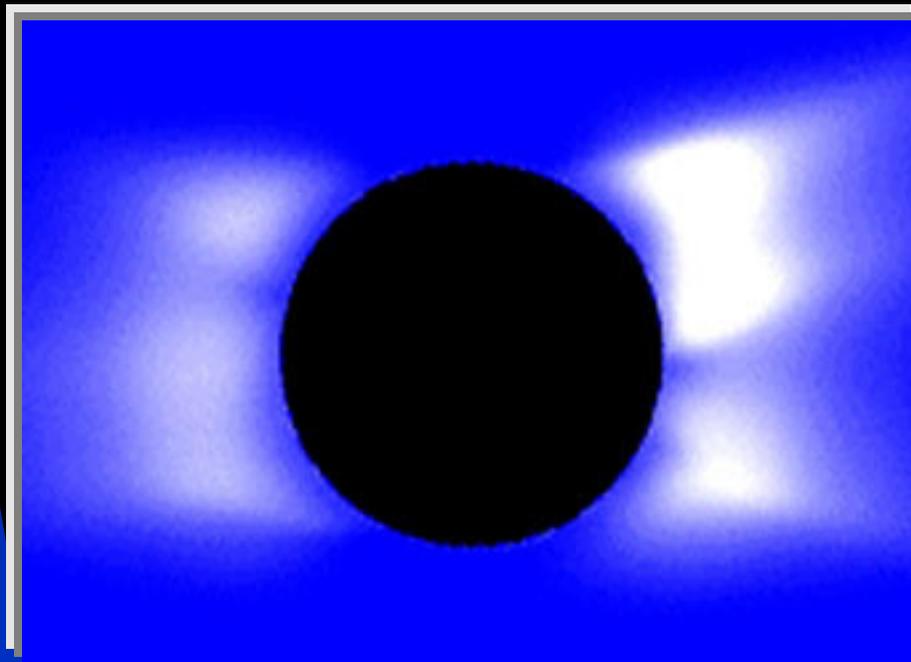


© Jean Mouette IAP-CNRS-UPMC 2006

© 2005 Google

Image © 2006 MDA EarthSat

Theoretical prediction for the total solar eclipse of 29 March 2006, 10:40 UT  
By Zoran Mikic et al.



**Let's be prepared !**

and ...  
« shokran »  
for your attention.