THE CORRELATION BETWEEN VISUAL MAGNITUDES AND WATER PRODUCTION RATES IN COMETS

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OBJECTIVES

Long before electronic detectors became available, visual magnitudes were used to estimate the brightness of comets. For some of them, visual magnitudes constitute the only piece of information available. For new comets, they can be extrapolated into the future quickly after their discovery.

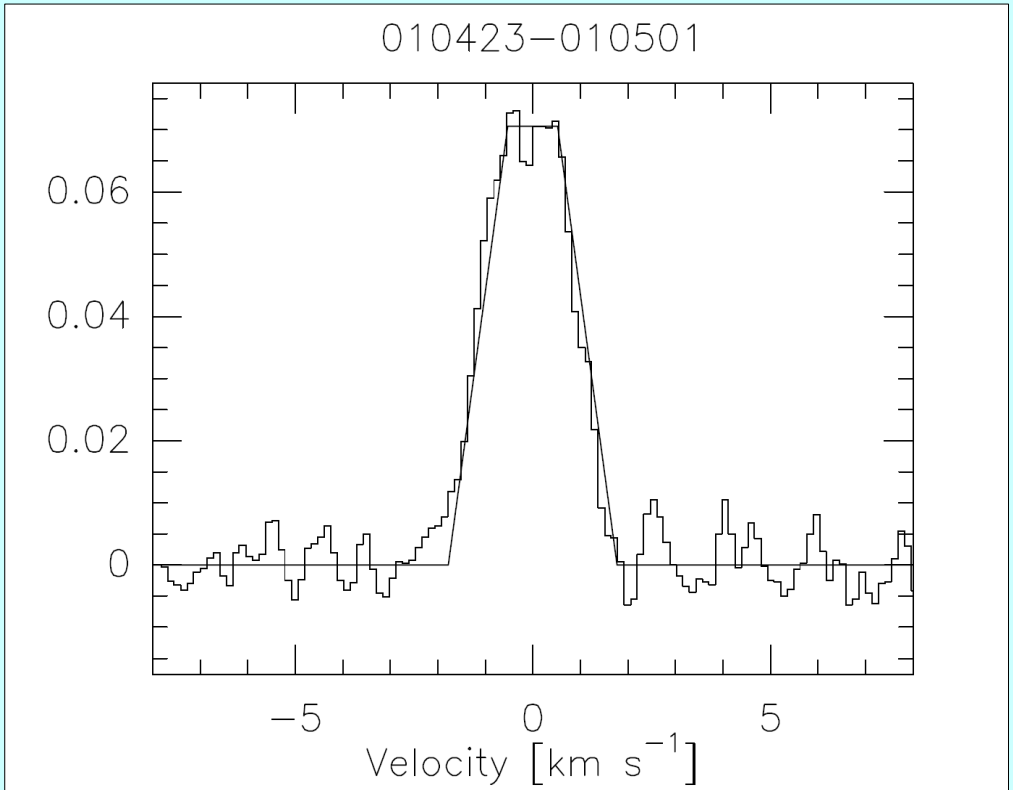
The aim of this study is to correlate the visual magnitudes of comets, including the bright comets C/1995 O1 (Hale-Bopp) and C/1996 B2 (Hyakutake), with their measured water-production rates. This work refines and extends to a wider range of magnitudes our previous correlation law [1].

WATER PRODUCTION RATES

OH production rates Q[OH] are calculated from the intensity of the OH radio lines at 18 cm observed at the Nançay radio telescope [2], [3]§. We deduce the water-production rate from the following relationship:

$$Q[H_2O] = 1.1\ Q[OH]$$

This gives a set of 241 water-production rates $Q[H_2O]$ which are used in our analysis.



OH spectrum of comet C/2001 A2 Linear

§See also URL: **http://lesia.obspm.fr/planeto/cometes/basecom/**

VISUAL MAGNITUDES

Visual magnitudes are extracted from the International Comet Quarterly data base [4]. We then calculate the average m_v and the standard deviation (r.m.s.) of the visual magnitudes measured during the time interval of each OH radio observation. Visual magnitudes are reduced to a geocentric distance Δ of 1 AU:

$$m_h = m_v - 5 \log \Delta$$

This gives a set of 241 heliocentric visual magnitudes m_h.

Comet C/1995 O1 Hale-Bopp (Courtesy N. Biver)

STATISTICAL ANALYSIS

We then perform a linear regression between the heliocentric magnitudes m_H and the water-production rates $Q[H_2O]$. We iteratively remove data points outside 3-σ of the residuals to obtain a set of 234 data points of 37 comets (see **Table**) which are best fitted by the following linear relationship:

$$\log Q[H_2O] = 30.675\ (0.007) - 0.2453\ (0.0013)\ m_H$$

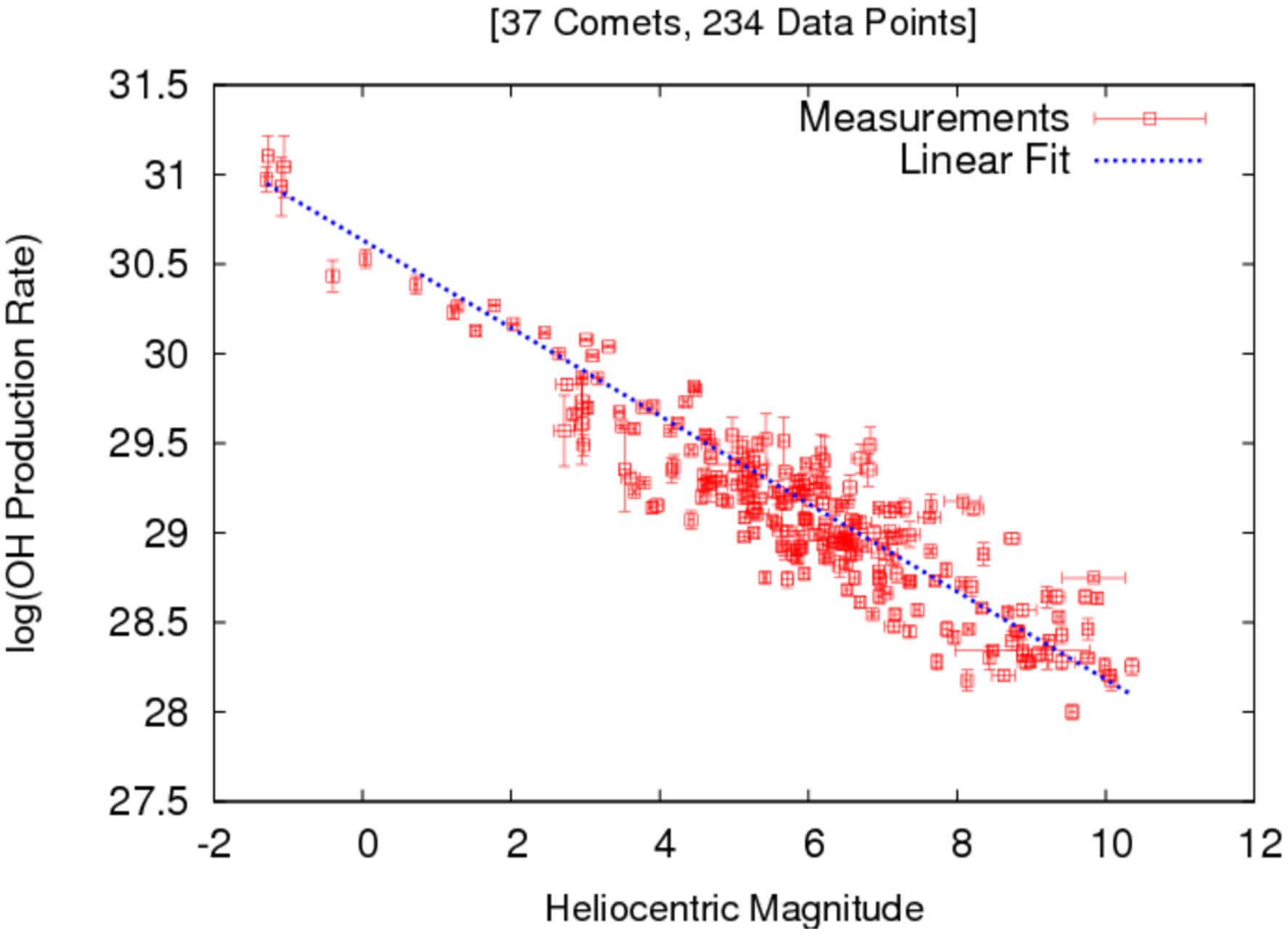
The residuals correspond to an uncertainty of a factor 1.6 at 1-σ and 3.7 at 3-σ. The regression coefficient is equal to $\rho = -0.94$.

DETAILS OF THE SAMPLE

Table. Parameters of the statistical sample of 234 data points used to build the correlation law.

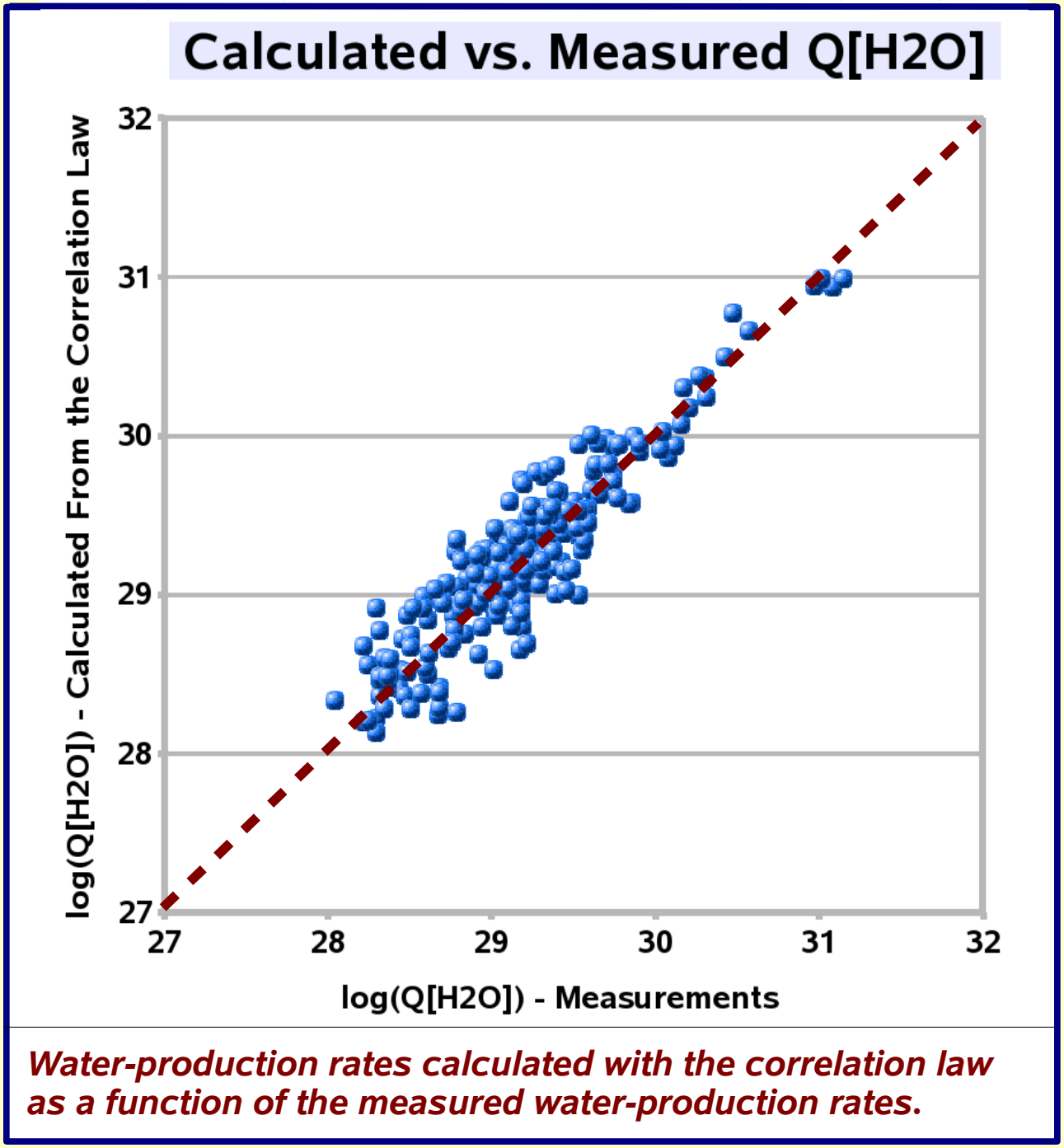
Parameter	Minimum	Maximum
Heliocentric distance	0.32 AU	3.7 AU
Geocentric distance	0.10 AU	3.0 AU
Heliocentric magnitude	-1.29	10.4
Water-production rate	$1.1\ 10^{28}\ s^{-1}$	$1.4\ 10^{31}\ s^{-1}$

CORRELATION LAW – ALL COMETS



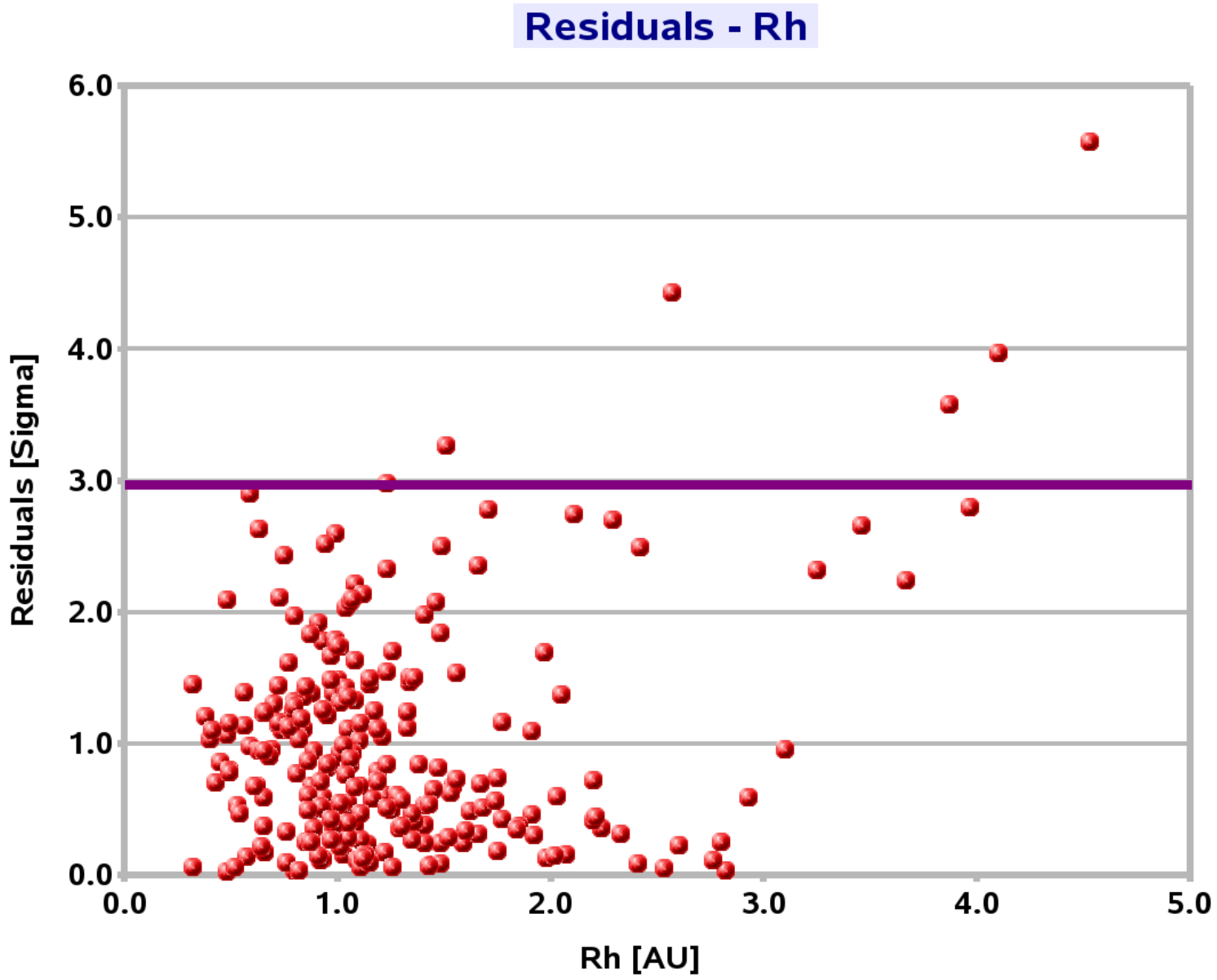
OH-production rates as a function of the heliocentric magnitudes of the 37 comets (234 data points) from which we derived our correlation law (dotted line).

CORRELATION LAW – ALL COMETS



Water-production rates calculated with the correlation law as a function of the measured water-production rates.

CORRELATION LAW – RESIDUALS



Residuals of the water-production rates (in units of their errorbar) as a function of the heliocentric distance at which the measurements have been acquired.

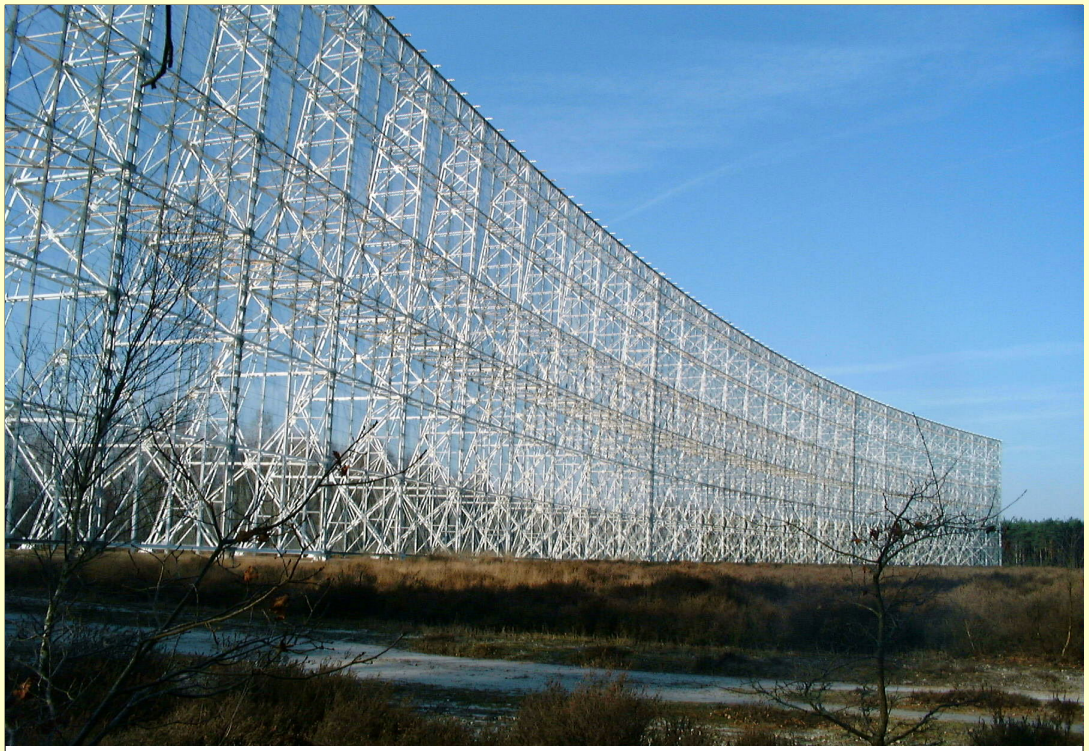
BIBLIOGRAPHY:

[1] Jorda, L., Crovisier, J., and Green, D.W.E., ACM 1991.

[2] Crovisier, J. et al., A&A 393, 1053, 2002.

[3] Crovisier J. et al., this conference

[4] Green, D.W.E., ICQ Archive of Photometric Data on Comets (Smithsonian Astrophysical Observatory).



The Nançay radio telescope: the fixed "mirror"

The Nançay radio telescope: aerial view