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THE CORRELATION BETWEEN VISUAL MAGNITUDES AND WATER PRODUCTION RATES

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Introduction: The correlation between water production rates and visual magnitudes has a great interest for studying the activity of past comets from historical data sets of visual magnitudes. It also allows us to predict the water production rate of new comets for the preparation of future observations. We present here an update of our previous relationship [1].

Data Sets: We use the visual magnitudes from the International Comet Quarterly data base [2] and the OH production rates from spectra obtained at the Nançay radio telescope [3, 4]. A total of 37 comets observed between Aug. 1982 and June 2004 have been used in our study. Our sample includes comets 1P/Halley during its 1986 return, C/1995 O1 (Hale-Bopp) and C/1996 B2 (Hyakutake). The data set represents 241 data points (see **Figure**). The heliocentric distances range between 0.32 and 4.53 AU.

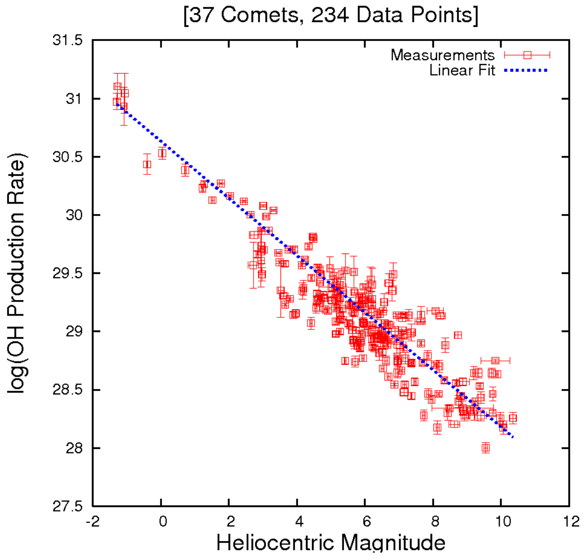

Figure. The red squares indicate the 234 data points, OH production rates vs. heliocentric magnitudes, used to calculate the correlation law (blue line). Note the wide range of heliocentric magnitudes.

Method of Analysis: The visual magnitudes m_V are first corrected from the systematic bias of each observer and reduced to a geocentric distance of 1 AU:

$$m_H = m_V - 5 \log \Delta,$$

where Δ is the geocentric distance of the comet at the time of the measurement. For the range of dates corresponding to a given measurement of the OH production rate, the average heliocentric magnitude and its associated error bar are computed. If no measurement is available (8 points out of 241), the magnitude is interpolated from magnitudes obtained before and after the OH measurement. This provides a set of 241 heliocentric magnitudes m_H and OH production rates Q[OH] with their error bars. We then perform a weighted linear regression analysis between m_H and log Q[OH]. During the analysis, we iteratively remove the "outliers" (points outside 3 times the RMS of the residuals). Only 7 such "outliers" are removed from the final linear regression during the process.

Results: We obtain the final following correlation law between the water production rate $Q[H_2O]$ and m_H for the 234 remaining data points (see **Figure**):

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

with a regression coefficient of –0.94. In the above relationship, we assume $Q[H_2O] = 1.1\ Q[OH]$. The parenthetical uncertainties in the above relationship are formal errors returned by the linear regression algorithm. In order to assess the accuracy of the final regression law, we calculated that the RMS of the residuals of log Q[OH] amounts to 0.190. This corresponds to factors of uncertainties on the calculated water production rate of 1.6 at 1-σ, 2.4 at 2-σ, and 3.7 at 3-σ. This law is very close to our previous determination [1] based on a smaller sample.

References:

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