EPSC Abstracts
Vol. 6, EPSC-DPS2011-251, 2011
EPSC-DPS Joint Meeting 2011


# An updated catalogue of absolute total magnitudes of long-period comets coming close to the Sun and their cumulative distribution

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## Abstract

We present a new catalogue of absolute total magnitudes for long-period comets that come close to the Sun comprising the last four decades of observations, and its cumulative distribution. Selection effects that may affect the discovery of comets will also be discussed.

## 1. Introduction

The precise determination of comet total magnitudes is an elusive problem since active comets do not appear as point sources but as nebulous sources. Aperture effects are among the several causes that can make observers to underestimate the comet magnitudes. CCD estimates are found, in general, to be several magnitudes fainter than the visual estimates (i.e. those made visually by telescope, binoculars or naked eye). Therefore we have recurred only to visual estimates in our studies. Selection effects that affect comet discovery must be taking into acount. As [2] pointed out, the potential discovery of long-period comets (i.e. comets that have been recorded once during the age of scientific observation) is a function of its brightness (which depends on the perihelion distance) and the comet-Earth-Sun geometry. The absolute total magnitude $H$ can be determined by means of

$$m_h = H + 2.5n \log_{10} r, \quad (1)$$

where $m_h$ is the total heliocentric magnitude (i.e. the total apparent magnitude corrected by the geocentric distance), $r$ is the heliocentric distance in AU, and $n$ is known as the *photometric index*. If $n$ = 4 is assumed, hence the magnitudes $H_{10}$ are determined instead of $H$. The most comprehensive catalogue of absolute total magnitudes $H_{10}$ for long-period comets has been done by [6] and later works by the same author and colleagues, spanning from ancient times up to the 1970's decade.

## 2. The sample and data sets

From the comet orbital catalogue by [3], we select those comets with orbital periods $P > 1000$ yr and perihelion distances $q < 1.3$ AU (hereafter $LPCs$), spanning from 1970 to 2009. The sample comprises a total number of 123 objects. The selected sample includes some outstanding comets like C/1995 O1 (Hale-Bopp), C/1996 B2 (Hyakutake), and C/2006 P1 (McNaught). The visual apparent magnitudes estimates were obtained from the *International Comet Quaterly (ICQ)* archive (except those observations prior to 2006, which were provided by [1]), and from the *International Astronomical Union Circulars (IAUCs)*. We follow the procedures explained in [4], and in [5], to extract and reduce the observational data, and to determine the observed light curve $m_h(t)$ as a function of time.

To determine $H$ and $n$ for a given comet from Eq. (1), we perform a least-square polynomial linear fit between the estimated $m_h$ values evaluated at the observational times $t$ and the logarithms of the computed $r(t)$ values. For some comets the observational coverage was not good enough to properly define $H$ from the linear fit (e.g. because of a lack of observations around $r \sim 1$, or because the photometric slope significantly varies within the observed range of $r$). In addition, most comets present a somewhat different slope before and after perihelion, hence different (a pre-perihelion, a post-perihelion, and a combined) linear fits were made in such cases. Therefore, for each comet of the studied sample, we made an educated guess to determine $H$ (based not only on the linear fits, but also taking into account the quality and completeness of the light curve, as well as the observations closer to $r \sim 1$ AU, when they exist). After the processing of the observational data, we were able to estimate $H$ for 103 LPCs of the selected sample.

## 3. Preliminary results and further work

In Fig. 1 we present the logarithm of the cumulative number of comets having absolute total visual magnitudes smaller than a specific value plotted as a function of the absolute magnitude, for our studied sample (we have omitted those comets with the most uncertain $H$ estimates). As a preliminary analysis, we can distinguish very bright comets ($H \lesssim 3$), bright comets ($3 \lesssim H \lesssim 6$), faint comets ($6 \lesssim H \lesssim 9$), very faint comets ($9 \lesssim H \lesssim 13$), and extremely faint comets ($H \sim 13$). For the bright and faint comets, we find that the logarithm of the cumulative number could be well fitted by a linear relation, namely,

$$log_{10}[N(< H)] = \alpha H + C \quad (2)$$

where the slope was found to be $\alpha$ = 0.48, and the constant $C$ = -1.4, for comets with $3.6 < H < 6.0$, and $\alpha$ = 0.20, and the constant $C$ = 0.2, for comets with $6.0 < H < 8.5$ .

Although the study of the degree of completeness for our sample has still to be carried out, as a first sight we can see that for $H \lesssim 9$ the observed distribution could be complete (assuming a bimodal distribution with a break point at $H \sim 6$), while for $H \gtrsim 9$ it increasing falls below the linear relation, suggesting an increasing degree of incompleteness.

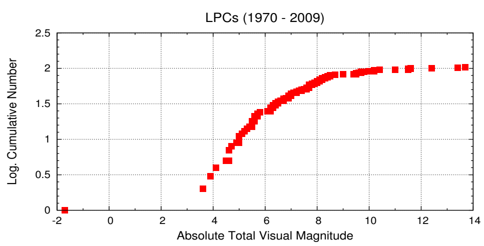


Figure 1: Cumulative distribution of the estimated absolute total visual magnitudes $H$ for the comets of the studied sample.

Since this is a work in progress, some important issues remain to be investigated, as for instance the existence of selection effects which could bias the observed distribution (and hence should be removed to assess the true distribution), comparison with earlier studies (i.e. prior to 1970), analysis of the photometric index for the comets of the sample, and comparison of the results with previous works.

## Acknowledgements

We thank Daniel Green for providing us data in electronic form from the ICQ archive.

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