Cosmic Masers: Proper Motion toward the Next-Generation Large Projects
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A database of circumstellar OH masers update

Dieter Engels[1] **and Belen López-Martí**[2]

[1]Hamburger Sternwarte, Universität Hamburg, Gojenbergsweg 112, 21029 Hamburg, Germany. email: dengels@hs.uni-hamburg.de

[2]Universidad San Pablo-CEU, Campus de Montepríncipe, 28668 Boadilla del Monte, Madrid, Spain

Abstract. The database of circumstellar OH masers by Engels & Bunzel (2015) was updated to include new 1612, 1665, and 1667 MHz OH maser observations published between 2015 and 2022. A cross-correlation of the database was made with infrared catalogues (AllWISE and 2MASS) and with GAIA DR3. This led frequently to significantly improved coordinates and identified contaminations with non-stellar sources. About 40% of all OH maser-detected stars were not detected by GAIA. These are mostly representatives of the population of highly obscured stars at the end of AGB or at the beginning of post-AGB evolution.

Keywords. masers, stars: AGB and post-AGB, circumstellar matter

1. New maser database release v2.5 including literature until 2022

The circumstellar envelopes of AGB stars frequently host masers emitted by the OH molecule with transitions at 1612, 1665, and 1667 MHz. Many of the optically very obscured stars at the end of AGB evolution (OH/IR stars) were discovered with surveys for these masers. The number of OH emitting stars discovered increased steadily from ∼130 (Engels 1979), to 439 (te Lintel Hekkert *et al.* 1989) (only 1612 MHz emitters) to >2300 (Engels & Bunzel 2015). The OH maser database was compiled with the aim to allow a quick access to the literature, where OH maser observations are reported. Observations published in refereed papers are now covered until 2022. Most new objects in the updated maser database were discovered by the large recent THOR (Beuther *et al.* 2019) and SPLASH OH maser surveys (Qiao *et al.* 2020) conducted along the Galactic plane. The database version 2.5 comprises ∼17000 observations and >2900 different stars detected in at least one transition (+24% relative to the 2015 release). The vast majority are Asymptotic Giant Branch (AGB) stars. About 130 stars (<5% of all stars with OH masers) have interferometric follow-up observations and/or were included in monitoring programs since the beginnings in the 1970s. The database is organized in three tables. The main table contains individual observations (maser velocities and flux densities), in addition to the coordinates. The two auxiliary tables monitoring projects and interferometric follow-up observations. A detailed description of the database is given in Engels & Bunzel (2015).

Access to the database is possible over the Web: www.hs.uni-hamburg.de/maserdb

2. Cross-correlations with the AllWISE, 2MASS and GAIA catalogues

We looked for counterparts of the OH/IR stars in the GAIA DR3 release to overcome the poor coordinate precision of many members of the maser database (López Martí

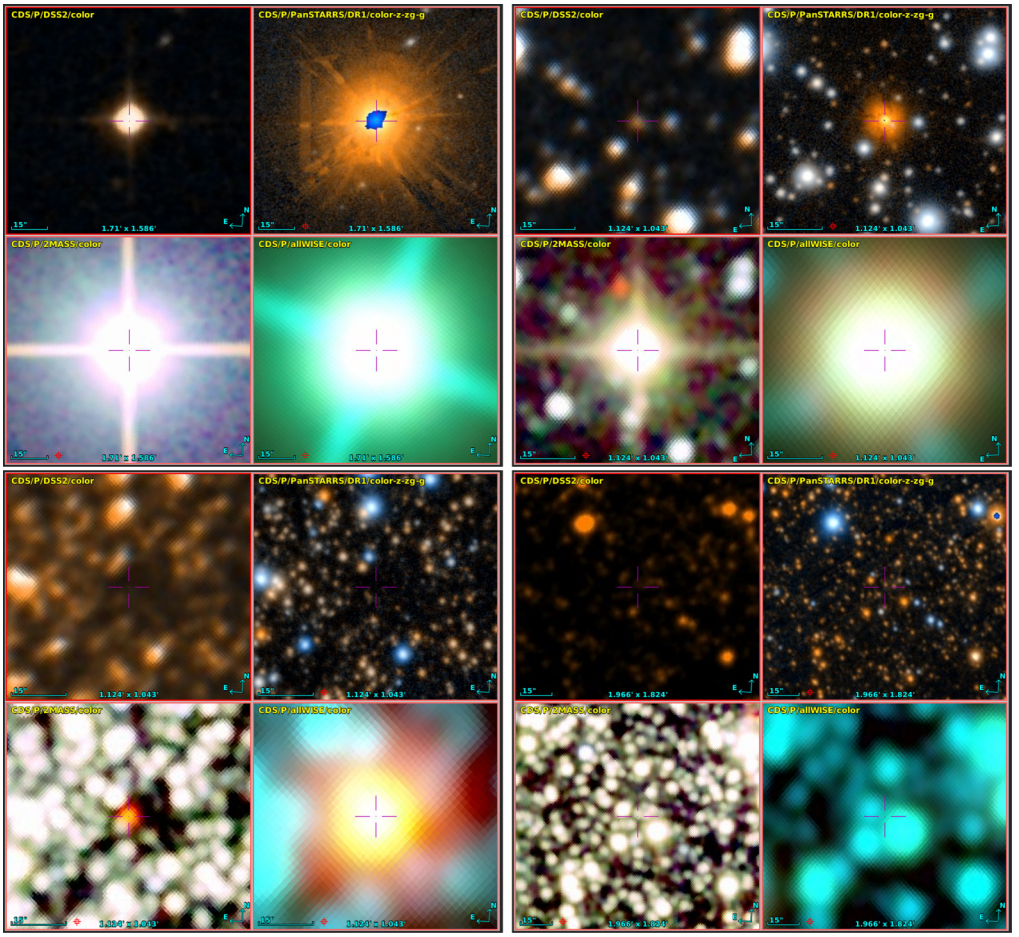

Figure 1. Displays from Aladin with counterparts on the Digital Sky Survey, on Pan-STARSS, on 2MASS (K-band; 2.2μm) and on WISE (W4 band, 22μm). The objects are a bright Mira variable T Vir (upper left), IRAS 19382+3400, an OH/IR star with optical counterpart (upper right), OH000.689+02.140, a strongly obscured OH/IR star (lower left), and OH356.524+02.526, an object without unambiguous IR identification.

et al. in preparation). Because a direct cross-match between the original coordinates and GAIA would have led to a great number of spurious detections, the process was done in several steps: First we did a cross-match of the database coordinates with the AllWISE Catalog, then we used the refined WISE coordinates to run a second cross-match with the 2MASS Point Source Catalog, and finally the 2MASS coordinates were used in a cross-match with GAIA DR3. We also used a successively decreasing cross-match radius to account for the improvement in the resolution from one survey to the next.

The cross match was visually supervised using the tool Aladin (Figure 1). Outside the Galactic plane ($|\,b\,|>2^\circ$) unique counterparts could be found usually within $\sim 1'$ (upper panels of Figure 1) of the maser input coordinates. In the plane and especially close to the Galactic Center, the interstellar extinction and the crowding of sources made the cross-match more difficult. Often a distinguished red WISE counterpart gave a unique identification (lower left panel of Figure 1), but at times no counterpart could be found. In these cases either the input coordinates seem to be erroneous or the maser was mis-classified and is of non-stellar origin (lower right panel of Figure 1).

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We could identify 93% of the OH maser sources listed in the database. 52% are present in the GAIA DR3 release, while 41% are too obscured and fainter than $G \approx 21$ mag at optical wavelengths. Significant improvements in coordinates of the IR/GAIA identified OH/IR stars could be achieved, with coordinate corrections reaching >10 arcsec for 9% of the stars. The inclusion of the improved coordinates for these stars (~ 2700 stars) is planned for the next release (Engels & López Martí, in preparation).

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