

# Mainline and Water Maser Observations of OH/IR stars in the Arecibo Sky

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A complete sample of color selected IRAS sources with  $S(25) \geq 2\text{Jy}$  in the Arecibo sky and ( $0^\circ \leq \delta \leq 37^\circ$ ) was examined previously for 1612 MHz masers. The resulting set of OH/IR stars has now been searched for mainline OH masers at Arecibo (Lewis 1997) and for 22 GHz water masers at Effelsberg (Engels & Lewis 1996). The high overall detection rate of 61.6% for the mainlines and 54.8% for water is partly a result of deployed sensitivity, and partly due to the many blue objects in the sample. But the detectability of both masers improves when  $S(25) > 20\text{Jy}$ , as the accompanying tables show. Still the bluest objects exhibit higher (usually  $\geq 80\%$ ) detection rates, while there is a clear decrease in detections from redder shells: this decrease begins circa  $(25 - 12) \mu\text{m} = -0.55$  for mainline masers, and abruptly circa  $(25 - 12) \mu\text{m} = -0.35$  for water. These trends adhere to the descriptive sequence of the chronological scenario for masers in circumstellar shells, though a few proto planetary nebulae and very red OH/IR stars have water masers and a few mainline masers are detected in shells with  $(25-12) \mu\text{m} \geq -0.2$ .

### Flux and Color dependence of Water Detection Rates

$(25-12) \mu\text{m}$	$S(25) > 50$	$50 > S(25) > 20$	$20 > S(25) > 10$	$S(25) < 10$
$< -0.40$	87% (20/23)	81% (25/31)	69% (33/48)	65% (79/122)
$> -0.30$	43% (6/14)	33% (6/18)	33% (9/27)	22% (10/45)
ALL	70% (31/44)	62% (33/53)	51% (47/92)	51% (99/194)

By taking account of water and/or mainline data, we estimate expansion velocities for many OH/IR stars in the sample with just a single 1612 MHz feature. Mainline emission from OH/IR stars is generally weaker than 1612 MHz emission, and it is very rare for all three masers to have their strongest features at exactly the same velocity. Since the extant OH data from IRAS 05506+2414 = BC Tau show a single broad feature at exactly the same velocity from all three lines, this source is probably a pre main sequence object rather than a proto planetary nebula.

### IR Flux Dependence of Mainline Detection Rates

$S(25)$	$(25-12) \mu\text{m} < -0.55$	$-0.55 < (25-12) \mu\text{m} < -0.1$	ALL
0-5 Jy	68% (26/38)	26% (16/61)	44% (46/105)
5-10 Jy	84% (21/25)	47% (26/55)	57% (51/89)
10-20 Jy	75% (15/20)	57% (37/65)	63% (58/92)
$> 20\text{Jy}$	82% (14/17)	82% (53/65)	84% (81/97)

### REFERENCES

- Engels, D. & Lewis, B. M. 1996, A.&A. Suppl., 116, 117,  
 Lewis, B. M., 1997, Ap. J. Suppl., April