

ACCURATE POSITIONS FOR YOUNG OBJECTS: NGC 7000 AND IC 5070

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RESUMEN

Como parte de un proyecto observacional en curso, cuyo propósito es determinar posiciones astrométricas de objetos asociados con nubes moleculares y/o localizados en regiones de formación estelar reciente, reportamos en este trabajo resultados para estrellas con emisión en las regiones de NGC 7000 e IC 5070. Las posiciones originales de Herbig difieren en menos de 10" de las posiciones determinadas astrométricamente. En particular, la posición astrométrica de V1057 Cyg y la posición del maser de OH en la región coinciden dentro de 1", confirmando la asociación física de los dos objetos.

ABSTRACT

As a part of an ongoing observational program to determine astrometric positions for objects associated with molecular clouds and/or located in regions of recent star formation, we report in this work results for Herbig emission-line objects in the regions of NGC 7000 and IC 5070. Herbig's original positions are within 10 arcsec of the astrometrically determined positions. In particular, the astrometric position for V1057 Cyg agrees within 1 arcsec with the position of the OH maser in the region, confirming the physical association between the two objects.

Key words: ASTROMETRY – STARS-PRE-MAIN-SEQUENCE

I. INTRODUCTION

We have undertaken an observational program aiming to obtain astrometric positions of objects in very early stages of evolution, still surrounded by remnants of the cloud from which they formed. The need for this type of program has become evident in recent years, since high spatial-resolution techniques in spectral regions other than optical have pointed to centers of activity that occasionally have not matched the positions of the optical counterparts. Although in some of these cases the position of the center of activity has coincided with the re-determined astrometric position, as in the case of MWC 1080 (Cantó *et al.* 1983), in other cases as T Tau (Simon *et al.* 1983), the confirmed disagreement has led to the discovery of hidden companions.

Results have already been reported for stars in NGC 2264 (Araque, Calvet, and Della Prugna 1983), and partial results are available for the list of Herbig's Ae and Be stars (Cova *et al.* 1983). In this work, we present astrometric positions for emission-line stars in NGC 7000 and IC 5070. This region of star formation is particularly interesting in that it contains V1057 Cyg (LkH α 190), one of the three known cases of a star that has undergone through the "FU Orionis" phenomenon, that is, a brightening of up to 6 magnitudes in time-scales of years (Grasdalen 1973; Herbig 1977). There is the suggestion that all T Tauri stars go through this eruptive-

type phenomenon once every 10⁴ years (Herbig 1977), so there is an increased likelihood that other faint T Tauri-type stars in the zone, presumably coeval with V1057 Cyg, could be in that phase of evolution just preceding the FU Orionis event. Probably related to the phenomenon that it has gone through, V1057 Cyg presents signs of activity in the molecular ambient surrounding it. For instance, narrow-band spectrophotometric observations between 2 and 4 μ suggest the presence of H₂O in absorption (Cohen 1975), while a 1720 MHz OH maser has been detected (Lo and Bechis 1973; Andersson *et al.* 1979; Winnberg *et al.* 1981), but only upper limits exist on an H₂O maser (Lo and Bechis 1974; Thum, Bertout, and Downes 1981).

II. THE DATA

The observational material consists of a 30 min, IIa F, unfiltered plate of the region obtained with the 1-m Schmidt Camera in the Llano del Hato Observatory, Mérida, Venezuela. We used initial positions and finding charts for the emission-line stars from Herbig (1959). The observational material was reduced using astrometric techniques described by Stock (1981), applied to a single plate. For this field, we used 19 reference stars from the AGK 3 Catalog. Measurements were done with a Zeiss PSK 2 stereo-comparator and reduced on a NOVA 3 computer.

TABLE 1

POSITIONS FOR STARS IN NGC 7000 AND IC 5070

LkH α	α (1950)	δ	LkH α	α (1950)	δ
442	20 ^h 45 ^m 51.34 ^s	43°36'18.5"	165	20 ^h 50 ^m 15.38 ^s	44°17'20.7"
134	20 46 18.58	43 36 18.1	166	20 50 18.30	44 26 08.2
135	20 46 33.88	43 28 39.7	167	20 50 19.20	44 26 09.9
136	20 48 47.26	44 04 23.2	168	20 50 20.01	44 05 55.2
137	20 48 51.34	44 07 08.5	169	20 50 21.13	43 52 23.3
138	20 48 51.36	44 09 33.8	MWC 1032	20 50 23.81	44 14 43.9
139	20 48 54.96	44 19 33.0	170 ^b	20 50 26.73	44 08 11.7
140	20 48 59.19	44 04 39.0	171	20 50 29.76	44 16 49.6
141	20 49 06.81	44 05 27.3	172	20 50 40.71	44 05 44.9
144	20 49 09.89	44 06 33.4	173	20 50 41.62	43 52 09.0
145	20 49 12.93	44 06 13.7	174	20 50 44.68	44 08 49.7
146	20 49 15.74	44 04 24.5	175	20 50 48.21	44 06 18.0
147	20 49 16.15	43 38 14.6	176	20 51 12.49	44 03 40.1
148	20 49 17.75	44 12 58.0	177	20 51 20.27	44 31 12.9
149 ^a	20 49 19.00	44 12 32.8	178	20 51 37.07	43 42 53.1
150	20 49 29.32	44 06 59.2	179	20 51 45.01	44 12 01.4
151	20 49 29.75	44 03 37.2	180	20 51 56.05	43 52 22.6
152	20 49 30.83	44 11 40.4	181	20 52 43.84	44 33 59.0
153	20 49 35.42	44 15 01.3	183	20 53 24.84	44 51 31.9
154	20 49 36.95	44 09 48.9	184	20 54 56.79	43 52 38.4
155	20 49 40.46	43 53 05.7	185	20 56 12.07	43 41 46.2
156	20 49 40.95	44 01 56.6	186	20 56 31.74	43 42 13.8
157	20 49 47.06	44 12 29.1	187	20 56 33.61	43 42 04.2
158	20 49 47.74	44 15 18.1	188 ^c	20 56 35.89	43 41 30.3
159	20 49 54.54	44 21 54.9	189	20 56 36.14	43 42 13.5
160	20 49 55.48	44 03 46.6	190 ^d	20 57 06.22	44 03 45.9
161	20 49 55.94	44 04 48.6	191	20 57 17.83	43 45 20.4
162	20 49 56.83	44 27 37.1	192	20 57 29.80	44 06 03.1
163	20 50 12.65	44 03 36.2	193	20 57 44.60	44 24 00.2
164	20 50 13.43	44 14 23.5	194	20 59 52.78	44 07 53.3
			195	21 00 13.30	43 18 54.2

- a. LkH α 149 = S7813
 b. LkH α 170 = V751 Cyg
 c. LkH α 188 = V521 Cyg
 d. LkH α 190 = V1057 Cyg

To estimate the error of the measurements, we have applied the transformations backwards to the reference stars and calculated the residuals between predicted and measured X-Y coordinates on the plate. A mean of these residuals in microns, transformed to seconds of arc using the Schmidt scale of 68.8 arcsec mm⁻¹ gives an estimated error of 0.3 arcsec in α and δ , assuming an internal accuracy of 0.3 arcsec for the AGK 3 (Stock, private communication).

The resulting astrometric positions, corresponding to equinox 1950.0 and epoch 1979.7 are given in columns 3 and 4 of Table 1. Column 1 of Table 1 gives the LkH α number as in Herbig (1959), and we give other designation when available, from Herbig and Rao (1972). Some stars of the original Herbig's list are missing. Stars LkH α 131-133 and 441 fell out of the useful plate field. Stars LkH α 142 and 143 are separated by

~ 2 arcsec, so that they could not be easily discerned in the plate, and we preferred not to measure them.

It is to be noticed that there is a fairly good agreement with Herbig's original positions, differences being at most of ~ 10 arcsec. In particular, there is an excellent agreement between the astrometric position of V1057 Cyg and the position of the OH source determined interferometrically: α (1950) = 20^h57^m06.3^s and δ (1950) = 44°03' 45.7" (Lo and Bechis 1974), confirming the physical association of the OH source with V1057 Cyg.

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