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A Working Catalogue of Herbig Haro Objects

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A working catalogue of Herbig Haro objects

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Summary. — We present a catalogue of 184 Herbig Haro objects from a literature search complete to 1987.5. It is intended to update the 1974 catalogue of Herbig. The catalogue contains accurate co-ordinates, proper motions, radial velocities and spectral information for these objects. A cross-reference to the two best finding charts is included. A grouping of Herbig Haro objects into « flows » is also listed.

Key words: Catalogue — Herbig Haro objects — Herbig Haro flows.

1. Introduction.

In 1974 Herbig published the first and only catalogue to date of Herbig Haro (HH) objects. Since then much has been achieved in this field ; about 100 new objects have been discovered, many from CCD imagery through narrow band filters, and significantly more data have been acquired for the previously known objects. HH objects are some of the most readily observable by-products of energetic mass flows from pre-main sequence stars (see reviews by Lada, 1985 ; Schwartz, 1983 ; Canto, 1983). They have given us much insight into the physical conditions in star formation regions and undoubtedly will continue to do so. In addition, the opening up of the submillimetre waveband makes timely an up-to-date compilation of these objects. In compiling a new catalogue we hope to provide an index to the literature, an aid to prevent unnecessary duplication of work, and an indication of where the gaps in current knowledge lie.

The Herbig Haro phenomenon can also arise in mass flow from evolved objects (e.g. the proto-planetary nebula OH 0739-14, Cohen *et al.*, 1985a). This is the only example known to us, and we are restricting this catalogue to HH objects in star forming regions.

The catalogue is based on a literature search complete to July 2, 1987. We also include work yet to be published to the extent that some researchers have kindly provided us with their data prior to publication. Throughout we have adopted the principle that the user's purposes are best served by presenting the observed data and not derived properties. In order to make the difficult decision between data sets presented by two or more groups studying the same object, we have favoured data taken with higher resolution equipment, and more recently acquired data.

The greater spatial resolution, sensitivity and dynamic range of modern instrumentation frequently reveals the subdivision of HH objects into smaller knots or condensations, and may also reveal faint nebulosity surrounding them. To the extent that the different knots or condensations show different motions or line ratios they should be separately recognised, and where the data are available we have done this in the catalogue. At the same time the association of several, clearly separate, HH objects with a molecular flow indicates that, arguably, flows are the important part of the HH hierarchy. We therefore also present a list of flows in which HH objects lie.

2. The Catalogue of HH objects.

Table I, « The Catalogue », is a list of all objects reported in the literature for which there is good evidence for their Herbig Haro classification. The objects are ordered in increasing right ascension. The catalogue contains accurate co-ordinates, proper motions, radial velocities, and spectral information for these objects. Errors are listed where known. A cross reference to the two best finding charts for each object is also included. The number of HH objects in this catalogue stands at 184, which may be only a small fraction of the number of

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such objects in the solar neighbourhood. As can be seen, many HH objects, under higher resolution, are found to belong to « families » of HH objects.

Inclusion in the catalogue is based on both the reference which provides the most accurate co-ordinates and the reference with the best spectroscopic data. In many cases accurate spectra have been published. In other cases the authors have indicated the object has HH spectra (for an indication of what an HH object spectrum should look like see Dopita, 1978, Fig. 3). Ideally, one should require a good spectrum with at least the two [SII] lines at $\lambda\lambda$ 6717 and 6730, the [OI] line at λ 6300, and H alpha at λ 6563. In many regions we have not been so strict as a number of knots have been discovered which belong to one flow, some of which are too faint to take such spectra. In such cases the referenced authors have included these objects as they not only appear to be HH objects morphologically, but also have measured proper motions and/or are associated with other known HH objects in a shocked gas region and/or seem to exhibit [SII] in emission. We have tried in all cases to be consistent in our criteria for inclusion in the catalogue. The spectroscopic reference should be consulted when trying to evaluate the strength of the claim the object has to the HH classification. In some cases references to the other columns will be helpful and this has been duly noted in the list of notes and references for tables I, II, III and IV.

Table II is a list of candidate HH objects also ordered in increasing right ascension. Most of these objects have no published proper motion, radial velocity, or emission line spectra. A number of the candidate objects have been referred to as HH objects in the past, yet no spectral or proper motion data are available. For example, HH 54Y seems to be part of a known larger association of HH objects, but is too faint to be anything more than a smudge on a CCD frame. Table II is not meant to be a complete list of all candidate HH objects (see for example Gyulbudaghian *et al.*, 1978 ; Reipurth, 1981, 1985a), but rather a list of objects that have been debated at some length in the literature.

Objects 17 and 48 of Herbig's (1974a, b) initial list have been deleted from our catalogue. Object 17 is a reflection nebula (Cohen and Schwartz, 1987, section IIIc), and object 48 is a T Tau star (Schwartz *et al.*, 1984, section IIIb). Objects 13 and 16 have been classified as candidate HH objects since we are aware of no spectral or proper motion data for these objects. Perhaps more questionably, we have included HH 97 here rather than in table I because Hartigan and Graham (1987) reported only Hα in its spectrum while reporting [SII] and [NII] for all the other objects in their study. Similarly we have listed HH 24D here rather than in table I because no part of this knot shows HH emission lines and only Hα is observed (Jones *et al.*, 1987). Objects 4 and 30 have also been classified as candidates. Object 4 is faintly observable in the [SII] frame of Strom *et al.* (1986) but Cohen and Schwartz (1987), citing Jones and Cohen (unpublished), indicate that it is not an HH object. Object 30 seems to be an embedded T Tau star though this is open to debate (Strom *et al.*, 1986). Though no spectrum has been taken of HH 6, this object has been included in table I because it exhibits H_2 emission evidence of shock excitation (Schwartz *et al.*, 1987).

Table I is organized as follows :

column 1 : the name of the HH object. Preference has been given to the naming scheme of Herbig (1974a, b). For other objects we give the designations by which they were first called. Some confusions have arisen, especially in the HH 24 region (see Jones *et al.* 1987, whose designations we use). A concordance is attempted in table IV. Designations simply prefixed by « HH », whether from Herbig's (1974a, b) catalogue or subsequent discoverers extending his numbering, are given without this prefix in table I. Other discoverers have included a nebular or stellar name in their designations and these are given in table I.

The abbreviation « sb » in this column indicates that the named object has considerable substructure, determined through direct imaging and/or radial velocity data, and that the co-ordinates refer to the apparent centre of the object ;

columns 2, 3 : the right ascension and declination in equinox 1950 co-ordinates. The accuracy of the co-ordinates quoted is the accuracy the referenced authors believed they achieved. Whenever the authors have given an indication of errors in positional co-ordinates, we have made mention of this in the list of notes and references following the tables. In somes cases, where no accurate positional reference can be found, we have measured the co-ordinates ourselves from published photographs, or maps, or survey plates. No epoch is listed after such determinations (except the survey plate measurements) and the initials of the person who made the measurement is given in the notes and reference list following the tables ;

column 4 : the epoch of the co-ordinates given in columns 2 and 3. This information is important as these objects have proper motion and may form and dissolve over time. Whenever the referenced authors have not given the exact epoch we have listed the range of possible epochs. The abbreviations « Palomar » and « ESO-B » (European Southern Observatory Blue Survey) indicate the plate material, and thus the epoch of the determination of the co-ordinates for those objects. The comment « epochs derived » in the list of notes and references indicates that we were forced to guess the epoch based on when the paper was written and when the authors indicated they had had telescope time ;

column 5 : the reference used for the determination of co-ordinates at the listed epoch. In many cases two good positional references existed for an object in which case priority was given to the more accurate and then the more recent.

columns 6, 7 : the proper motions of the object in right ascension and declination in arc seconds per century. Listed errors are those given by the referenced author. Where no error value is given, the author usually had only two plates to derive proper motions, and therefore no direct way of evaluating internal errors. A decimal point following a quoted value indicates, here and in later columns, that we have taken the liberty of removing digits to economize on the size of the catalogue. In all such cases, no data are degraded significantly as the quoted errors exceed the values of the digits removed ;

column 8 : the reference used in the evaluation of proper motion ;

column 9 : the heliocentric radial velocity of the object in kilometers per second. The listed errors are those given by the referenced author. The symbol « c » indicates that the velocity structure is more complex than a few radial velocity values can represent. Often, this is a strong indication of further spatial substructure not yet resolved. Velocities followed by an « L » are velocities relative to the Local Standard of Rest. The abbreviation « M » indicates that the velocity is the mean velocity of the entire family of HH knots. This is used only for the four knots of HH 1 as the positions of spectroscopic observations do not coincide with Herbig's knot positions ;

column 10 : the reference used for the listed radial velocity. Preference is given to those references which claimed the highest accuracy in their velocity determination and were aware of the greatest degree of complexity in the velocity field. Some authors have made painstaking maps of the velocity fields of these objects and the reader is particularly refered to Böhm and Solf (1985) for HH 1 and 2, and Solf *et al.* (1986) for HH 32. CCD photographs in the light of strong lines at different velocities have also been published (see e.g. Strom *et al.*, 1986) ;

column 11 : the observed line flux divided by the Hβ line flux, multiplied by 100. This column has four subcolumns, for the [OIII] λ5007 line, the [OI] λ6300 line, the [SII] λ6716 line, and the [SII] λ6731 line, respectively. These lines were chosen both because they are readily observed in HH objects, and because they yield useful physical parameters for the region. Indeed, the [SII] lines are a prime determinant of HH object status (Böhm, 1975).

The [SII] line ratio is often used to determine electron density and the [OIII] λ5007 to Hβ ratio the temperature (Osterbrock, 1974, pp. 100, 112). Additionally, although [OI] $\lambda\lambda$6300 and 6364 are present together, here their strengths are related only by their transition probabilities (a value of 3.2 with λ6300 the stronger, Osterbrock, 1974, p. 244). We have therefore chosen to list the stronger line of the pair as it likely is measured with greater accuracy. If a choice existed between line strengths relative to Hβ or Hα, the former was always chosen over the latter. This tended to be the more common method of exhibiting the information, and in general, was used for data of higher quality. Whenever the spectral region of a line was observed but no line strength reported, either because the instrument resolution was too low or because the line actually did not exist, we have placed a « — » symbol in the appropriate spectral column. A list of symbols and abbreviations used in these and other columns is given following table I. Unlike the other columns, some study of this list will be required to follow the format of the information presented here ;

column 12 : the amount of extinction along the line of sight to the optical line-forming region of the HH object. These values have been determined by a number of techniques and the listed symbols indicate the method and provide a reference. The data are heterogeneous and we have not attempted to convert them to a uniform unit, such as A_V, as this would imply knowledge of the reddening law. If there is a significant local extinction component, it might well not follow the « standard » interstellar law ;

column 13 : the reference quoted for the spectral and absorption information. Preference has been given to those works with the greatest claimed accuracy and the most recently acquired data. If a reference is given without spectral or absorption information, this indicates that the spectra of the object is discussed in a form not immediately presentable in our catalogue. These references should be consulted when evaluating the claim the object has to the HH classification ;

column 14 : references to the two best finding charts available in the literature. Emphasis has been placed on images which show the structure of the nebulosity, rather than the pattern of nearby stars useful for finding the object in the telescope. These references sometimes give an indication of the brightness of the object. We have not attempted a tabulation of brightness in this catalogue because these data are too heterogeneous.

3. A list of HH object flows.

Molecular flows are believed to be an important part of the HH hierarchy. Strom *et al.* (1986) have compiled a table of optical flows from their atlas of CCD images and Mundt *et al.* (1987) gives detailed physical data for some HH object flows. We present some properties of identified flows in table III, but have not attempted to derive physical parameters for them. This table lists the individual HH objects believed to belong to each flow (about which there is not always agreement) and information about the candidate exciting stars. Specifically :

column 1 : the name of the flow. These names have been chosen to reflect common usage, or where infrequently discussed, are a designation based on the participating HH objects. A « P » following the flow name indicates that the referenced authors listed the flow as a possible flow ;

column 2 : the names of the HH objects which are believed to be members of the particular flow. Some regions are complex, containing more than one flow, and different studies assign individual HH objects to different flows. We have sought to reflect this in the table ;

column 3 : the reference used to determine HH object membership in a particular flow ;

column 4 : the cloud which contains the flow. A cross reference of cloud names used in this work can be found below table III ;

column 5 : the distance to the cloud in parsecs. Where distance is other than cloud distance this is indicated in the notes and references ;

column 6 : the reference used in the distance determination ;

column 7: the reference identifying a far infrared source with the flow and/or its exciting star ;

column 8 : the optical exciting star of the flow. Raw numbers in this column are IRAS point source numbers where these exist and no other name has been given for the exciting star ;

column 9 : the reference used to identify the optical exciting star ;

columns 10, 11 : the right ascension and declination of the optical exciting star in equinox 1950 co-ordinates ;

column 12 : the reference used for the determination of co-ordinates ;

column 13 : the spectral type of the optical exciting star ;

column 14 : the V magnitude of the optical exciting star ;

column 15 : the K magnitude of the optical exciting star ;

column 16 : the reference(s) used to determine the spectral type and the V and K magnitudes of the optical exciting star ;

column 17 : the absorption in visual magnitudes along the line of sight to the optical exciting star ;

column 18 : the reference used to determine absorption.

A cross reference to the HH naming schemes commonly found in the literature can be found in table IV. Note, in particular, that the names of the HH knots 24D and 24E have been interchanged by different authors. Note also that Herbig's initial list did not have knots named 1A or 3A to 14A inclusive, so any name with an « A » in this range is a later addition. These may repeat another number of Herbig's designation, or may refer to previously unrecognized knots.

This illustrates how the naming of Herbig-Haro objects and their components can become confusing as more sensitive observations reveal ever more structure. At this stage, we prefer to reconcile the existing names rather than attempt a new nomenclature on IAU-approved lines (e.g. Dickel, *et al.*, 1987). There is a pressing need for a uniform survey of star-forming regions by an appropriate technique (e.g. in the light of shock-excited lines). This could then lead to a more uniform catalogue, including the present objects discovered in a variety of ways, for which a new, systematic nomenclature would be appropriate.

4. Conclusions.

We have presented a catalogue of 184 Herbig Haro objects from a literature search complete to 1987.5. It is intended to update the 1974 catalogue of Herbig. We hope it will serve as a useful tool both for comparison with catalogues of other objects (molecular flows, infrared sources, etc.) and for an index to what is available in the literature. We would appreciate being notified of any errors or omissions in this work. We are maintaining a machine-readable version of the catalogue which we happily will provide on request.

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Note added in proof: Dr. Jones has informed us that the declination of RNO 40 given in table I (cf. note 11) is incorrect ; it should be – 5 54 44-8.

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TABLE I. — *List of 184 Herbig Haro objects.*

HH name	R.A. (1950)	Dec.	epoch	rf	μ_x ("/cen)	μ_y	rf	R.V. (km/s)	rf	observed flux(Hβ=100) [OIII] 5007	[OI] 6300	[SII] 6716	[SII] 6731	Extn	rf	chart
14C	03 25 44.1	30 50 29	1946-65	2											2	
14E	03 25 44.4	30 50 56	1946-65	2											2	
14D	03 25 44.8	30 51 05	1946-65	2											2	
14B	03 25 45.0	30 50 50	1946-65	2											2	
12D	03 25 52.39	31 09 51.1	1982.0	7	0.5±3.8	5.5±2.0	7	-52±3	66	-	-	296	200 e		66	37, 2
12C	03 25 52.4	31 10 04	1946-65	2				-52±3	66							37, 2
12G	03 25 53.1	31 10 26	1946-65	2				-52±3	66							37, 2
15	03 25 53.5	30 57 43	1946-65	2												2
12B	03 25 53.52	31 10 13.0	1982.0	7	5.0±0.7	14.4±0.6	7	-52±3	66				p		2	37, 2
12E	03 25 53.69	31 09 48.6	1982.0	7	1.5±1.7	3.2±1.7	7	-52±3	66		p				2	37, 2
12F	03 25 53.72	31 09 31.0	1982.0	7	-3.1±1.2	10.2±1.1	7	-52±3	66		p		p		2	37, 2
11B	03 25 58.99	31 05 33.1	1982.0	7	1.4±2.1	-4.3±2.1	7	-133±17	66	23b	632b	404	586 e	.54E	52	37
11A	03 25 59.05	31 05 34.7	1982.0	7	3.0±0.5	-1.8±0.8	7	-133±17	66							37
10	03 25 59.83	31 05 29.2	1982.0	7	-1.1±2.0	-1.0±2.0	7	-16±	66	-	740b	780	770	.54E	52	37
8A	03 26 00.68	31 05 18.7	1982.0	7	-2.2±2.0	1.7±2.0	7	-31±	66	-	500b	580	450	.54E	52	37
9	03 26 00.9	31 05 35	1946-65	2									p		37	37
7C	03 26 02.3	31 05 08	1946-65	2				-45±14	66	<17	429	3114	- e	.21E	37	37
7B	03 26 02.56	31 05 10.1	1982.0	7	3.0±2.1	1.9±2.1	7	-45±14	66							37
7A	03 26 02.78	31 05 10.8	1982.0	7	1.4±2.0	2.9±2.0	7	-45±14	66							37
6D	03 26 05.8	31 08 10	1946-65	2											37	37, 2
6C	03 26 06.5	31 08 15	1946-65	2											37	37, 2
6E	03 26 06.6	31 08 24	1946-65	2											37	37, 2
6F	03 26 07.0	31 08 23	1946-65	2											37	37, 2
6B	03 26 07.2	31 08 28	1946-65	2											37	37, 2
5	03 26 14.78	31 02 32.3	1982.0	7	1.8±2.0	-2.1±2.5	7				p		p		2	2
N1555/HH	04 18 34	19 25 05		17				-34±14	61			(p)			61	61
DGTau/HH	04 23 55.5	25 58 28		84				-125±10	84	28	114	92	169	.39	26	84
31D	04 24 53.3	26 12 41	1983-85	36				+131±55	26		p				26	37
31B	04 25 13.8	26 11 35	1946-65	2							p		p		2	37, 2
31C	04 25 14.3	26 10 24	1946-65	2												37, 2
31A	04 25 15.2	26 11 33	1946-65	2							p		p		2	37, 2
28	04 28 13.5	17 57 02	1946-65	2	-16.±3.	-13.±3.	7	-21±14	26				p		2	2
102sb	04 28 25.3	18 00 57	Palomar	66				-44±	66	-	102	109	59		66	66
29	04 28 33.7	18 00 01	Palomar	66	-13.±1.	-19.±1.	7	-28±2	66	-	123	235	208		66	2
RNO40	05 17 13.80	-05 55 44.8	1977.12	11	-3.6±0.3	-1.9±1.1	11			33b	370b	280	340	.46E	52	11,66
RNO43A	05 29 38.97	12 51 12.1	1977.12	11	3.9±0.4	14.9±0.4	11			11b	236b	324	- e	2.27	11	11,66
RNO43D	05 29 43.98	12 57 44.0	1977.12	11	-0.6±	5.5±	11									11,66
RNO43B	05 29 44.64	12 55 46.7	1977.12	11	0.4±	2.3±	11									11,66
M42/HH2	05 32 44	-05 24 40	1977.0	35				+25±3 , -30±3	c 35			67S	100S		35	35,62
M42/HH1A	05 32 44.01	-05 23 48.6	1983.02	20	-6.3±0.6	4.3±0.4	20	+23±3	c 35		275S	80S	100S		54	35,62
M42/HH1B	05 32 44.01	-05 23 48.6	1983.02	20	-6.3±0.6	4.3±0.4	20	-254±3	c 35		67α	29α	36α		54	35,62
M42/HH5	05 32 44.29	-05 22 22.9	1983.02	20	-2.9±0.8	10.5±0.6	20				p				21	21
M42/HH6	05 32 45.0	-05 22 32	1979.14	21							p				21	21
M42/HH7	05 32 45.2	-05 22 43	1979.14	21							p				21	21
M42/HH8	05 32 46.3	-05 24 15	1979.14	21							p				21	21,62
M42/HH9	05 32 46.4	-05 23 40	1979.14	21							p				21	21
M42/HH10	05 32 47.93	-05 22 37.8	1983.02	20	2.8±0.5	9.5±0.7	20				p				21	21
44	05 32 48.5	-05 12 19	1976.26	3								(p)			3	3
33	05 32 51.5	-06 19 35	1946-65	2									p		2	37,63
40	05 32 54.5	-06 20 16	1946-65	2						91b	111b	277	390	.49E	52	37,63
M42/HH3	05 32 54.8	-05 26 51		68				+18±3 , -46±3	35			51S	100S		35	68
M42/HH4	05 32 55.2	-05 27 06		68				+20±3 , -16±3	35			48S	100S		35	68
34 sb	05 33 05.4	-06 30 28	1946-65	2				-97±10, -59±10	29			42cm	30cm		29	37,29
45	05 33 06.3	-04 52 43	1976.26	3								(p)			3	3
41	05 33 34.1	-05 04 40	1946-65	2								(p)			3	63
42A	05 33 37.3	-05 06 31		8								(p)	e		3	63
42B	05 33 40.9	-05 06 31		8												63
3	05 33 45.77	-06 44 53.4	1982.0	7	-0.4±0.5	0.8±0.3	7	+7±6	L 45	36.7	121	142.	140.	.2o	56	2,63
1F	05 33 54.54	-06 46 57.0	1982.0	7	-9.9±2.6	12.7±2.0	7	-6±	M 31	49	220	122	185 e	.4E	50	37,65
1D	05 33 54.70	-06 46 59.0	1982.0	7	-6.2±0.9	9.4±0.6	7	-6±	M 31							37,65
1C	05 33 54.83	-06 46 59.2	1982.0	7	-5.7±0.6	7.4±1.0	7	-6±	M 31							37,65
1A	05 33 54.85	-06 47 01.2	1982.0	7	-2.7±0.8	6.6±1.3	7	-6±	M 31							37,65
35	05 33 56.6	-06 43 40	1946-65	2												2
2D	05 33 59.35	-06 49 04.0	1982.0	7	-0.9±0.6	-3.8±1.0	7				p		p		2	37, 2
2A	05 33 59.44	-06 48 59.2	1982.0	7	3.0±	-6.3±	7	+21±4	33	94.0	215	122.	184.	.59o	56	37, 2
2I	05 33 59.65	-06 49 08.5	1982.0	7	2.8±0.5	-10.5±2.1	7								2	37, 2
2C	05 33 59.67	-06 48 55.5	1982.0	7	6.9±0.8	13.5±1.1	7	+31±5	33	52	433	192	382	1.33s	45	37, 2
2H	05 33 59.69	-06 49 03.8	1982.0	7	5.6±0.4	-9.6±0.6	7	+13±2	33	85.0	202	70.2	138.	.59o	56	37, 2
2B	05 33 59.89	-06 48 56.3	1982.0	7	1.9±0.5	-4.2±0.6	7	+13±6	33	56.7	180	245.	285.	.59o	56	37, 2
2G	05 34 00.11	-06 48 57.1	1982.0	7	3.9±0.5	-5.8±0.4	7	-2±8	33	43.0	236	129	231	.59o	56	37, 2
2E	05 34 00.70	-06 49 00.4	1982.0	7	-0.3±0.6	-2.8±1.0	7	+39±6	33		117α	96α	125α		33	37, 2
2L	05 34 00.8	-06 49 15	1946-65	2				+11±3	33	-	875	1315	1400	1.25s	45	37, 2
43A	05 35 45.4	-07 11 04	1946-65	2				+44±28	32	54.2	86.3	138.	80.4	.2E	32	37,66
43B	05 35 45.4	-07 11 04	1946-65	2				-34±19	32	-	349.	445.	375.	.2E	32	37,66
43C	05 35 45.4	-07 11 04	1946-65	2				-143±21	32	-	405.	473.	516.	.2E	32	37,66
38	05 35 56.5	-07 13 18	1946-65	2									p		2	2
N2023/HH2A	05 38 55.58	-02 24 30.0	1984.09	10	-5.50±	3.20±	10									10
N2023/HH2B	05 38 56.33	-02 24 34.8	1984.09	10	-7.69±	12.0±	10									10
N2023/HH1C	05 39 00.35	-02 18 54.6	1984.09	10	-3.07±	-5.94±	10	-8±17	10	-	485	571	582 e	3.4	10	10
N2023/HH1B	05 39 00.37	-02 18 49.8	1984.09	10	-3.07±	-5.94±	10	-8±17	10							10
N2023/HH1A	05 39 00.86	-02 18 52.2	1984.09	10	-1.96±	-0.84±	10	-100±22, -50±9	c 10							10
N2023/HH3A	05 39 01.31	-02 25 11.0	1984.09	10	2.93±	2.24±	10	-30±21, +27±8	10			(p)	e		10	10
N2023/HH3B	05 39 01.90	-02 25 07.8	1984.09	10	-2.61±	-7.49±	10	-30±21, +27±8	10							10
N2023/HH3C	05 39 02.21	-02 25 02.7	1984.09	10												10
N2023/HH5	05 39 02.85	-02 18 43.6	1984.09	10						-	198	570	481	2.6	10	10

TABLE I *(continued)*.

HH name	R.A. (1950)	Dec.	epoch	rf	μ_x ("/cen)	μ_y	rf	R.V.	(km/s)	rf	observed flux(Hβ-100) [OIII] 5007	[OI] 6300	[SII] 6716	[SII] 6731	Extn	rf	chart
N2023/HH4	05 39 03.9	-02 18 24	1984.09	10							-	362	552	594	3.3	10	10
19C	05 43 15.28	-00 06 12.0	1980.94	69	-2.5±	2.9±	69	-4±		69	-	215	265	265	1.5	69	37,69
19A	05 43 15.98	-00 06 19.7	1980.94	69	-1.6±0.5	1.9±0.5	69	-33±		69	40	175	175	200	1.5	69	37,67
20	05 43 21.43	-00 04 11.3	1980.94	69	-2.3±0.5	6.5±0.2	69	-109±		69	-	85	170	175	1.5	69	37
21	05 43 22.0	-00 05 36	1946-65	1													37
26	05 43 31.14	-00 15 42.8	1980.94	69	-0.5±	-0.3±	69	-130±	, -15± c	69	-	182α	209α	290α		69	37,69
25	05 43 33.4	-00 14 31	1946-65	1				+143±	, -80±	69	-	51α	121α	58α		69	37,69
24C2	05 43 34.15	-00 10 46.5	1980.94	69	-6.6±0.7	13.1±1.3	69	-184±		69	-	170	245	225		69	37,69
24Csb	05 43 34.4	-00 10 53	Palomar	66				-88±		66	-	343	443	476 e		66	37,69
24B	05 43 34.44	-00 11 11.7	1980.94	69	-0.2±0.2	0.8±0.2	69	-72±		69	-	190	175	205		69	37,
24E	05 43 35.0	-00 10 34	Palomar	66				+60±		69	-	260	290	285		69	37,66
24A	05 43 35.66	-00 11 31.4	1980.94	69	-1.4±0.5	-0.8±1.0	69	+48±		66	26	221	179	246	.71E	57	37, 2
24G1	05 43 37.5	-00 10 30	1983-85	37				-133		69	-	-	50α	56α		69	69,37
24G2	05 43 38.3	-00 10 17	1983-85	37				-129		69	-	60α	56α	61α		69	69,37
24G3	05 43 39.3	-00 10 10		69				-140		69	-	-	48α	91α		69	69
23	05 43 40.86	-00 04 36.5	1980.94	69	-1.3±	1.1±	69										37
27	05 43 49.4	-00 14 45	1946-65	1				+60±	, -35± c	69	-	69α	122α	116α	3.1	69	37,69
GM10A	05 59 53.5	-09 06 25	1982.9	85				-53±31		19		13α	18α	18α		19	19
GGD18	06 31 57.0	04 15 12	1954.0	85								p	p	p		40	37
39C	06 36 21.08	08 53 50.0	1982.0	7	1.7±0.5	8.0±0.5	7	+20±20		47		p		p		2	2,47
39B	06 36 21.30	08 54 07.0		47													2,47
39D	06 36 21.43	08 53 40.8	1982.0	7	-1.0±0.6	1.2±1.4	7										2,47
39E	06 36 21.54	08 53 48.1	1982.0	7	-3.6±0.6	6.3±3.4	7										2,47
39A	06 36 21.60	08 54 13.2	1982.0	7	-1.5±1.1	7.1±0.5	7	+20±20		47		p		p		2	2,47
39F	06 36 22.8	08 53 35	1946-65	2													2,47
N2264HH11-6	06 38 16.9	09 42 28	1978	25							-	150	(292)		.3E	25	37
N2264HH11-7	06 38 17.2	09 42 42	1978	25				+34.±.7,	+59±3	25	-	270	(600)		.3E	25	37
N2264HH14-6	06 38 17.7	09 47 09	1978	25													37
N2264HH14-4	06 38 18.4	09 47 24	1978	25													37
N2264HH14-5	06 38 18.7	09 47 19	1978	25							-	100	(417)		.3E	25	37
120	08 07 40.0	-35 56 02	ESO-B	15				-42±12		30	<2	680	803	988	.32E	30	15
Re 4 head	08 19 28.9	-49 25 12		53				-29±2		53		48α	17α	24α		53	53
47CS	08 24 05.64	-50 51 48.5	1983.26	6	-11.0±	-5.2±	6	+91±15		22	-	240	350	270 e	.7h	51	6,22
47CN	08 24 05.68	-50 51 45.3	1983.26	6	-9.6±	-7.1±	6	+124±15		22	-	240	350	270 e	.7h	51	6,22
46	08 24 16.77	-50 50 41.1	1983.26	6	1.7±10.	10.2±23.	6	-189±15,	-125±15	22	10	399	229	274	.37s	45	6,22
47BS	08 24 18.19	-50 50 30.1	1983.26	6	-4.6±6.2	1.9±23.	6	-138±15		22							6,22
47BN	08 24 19.26	-50 50 23.3	1983.26	6	1.8±2.7	7.7±8.8	6	-144±15		22							6,22
47AN	08 24 22.83	-50 49 59.3	1983.26	6	4.0±1.4	7.4±2.4	6	-123±15		22	-	342	486	511 e	.1h	51	6,22
47AS	08 24 22.91	-50 50 03.4	1983.26	6	0.6±4.5	9.0±5.4	6	-111±15		22	-	342	486	511 e	.1h	51	6,22
49	11 04 37.13	-77 17 21.8	1983.26	6	4.5±1.2	-15.0±3.2	6	+25±3		34	66.3	43.2	34.8	42.4	.56h	34	6
50A	11 04 39.33	-77 16 53.3	1983.26	6	-12.9±2.4	-44.9±0.3	6										6
50D	11 04 39.37	-77 16 45.1	1983.26	6	-6.3±	-22.4±	6	+30±5	M	34	9.7	80.8	131	127 e	1.02h	34	6
50C	11 04 39.57	-77 16 47.2	1983.26	6	-6.3±	-20.1±	6										6
50B	11 04 39.70	-77 16 51.1	1983.26	6	-9.0±2.0	-34.0±1.0	6										6
50E	11 04 43.06	-77 16 29.8	1983.26	6	-1.1±	-23.7±	6										6
51	11 08 21.5	-76 08 01	1976.27	3									(p)			3	3
52	12 51 28.03	-76 41 35.5	1983.26	6	3.7±4.2	2.4±5.5	6	-99±10		34			(p)			3	6,12
53B	12 51 35.21	-76 41 12.4	1983.26	6	-1.6±2.7	-0.6±0.8	6	-101±23		34			(p)	e		3	6,12
53A	12 51 36.21	-76 41 12.0	1983.26	6	-3.8±2.7	-2.0±4.9	6	-101±23		34							6,12
53C	12 51 36.7	-76 41 12	1984	12				-101±23		34							12
54X	12 52 00.31	-76 41 20.2	1983.26	6	-6.6±	-8.8±	6										6,12
54G	12 52 05.3	-76 39 55	1984	12				-78±6		34							12
54A1	12 52 08.6	-76 40 16	1984	12									(p)	e		3	3,12
54F	12 52 08.8	-76 40 01	1984	12				-32±7		34							12
54A2	12 52 09.2	-76 40 13	1984	12									(p)	e		3	3,12

TABLE I *(continued)*.

HH name	R.A. (1950)	Dec.	epoch	rf	μ_x ("/cen)	μ_y	rf	R.V. (km/s)	rf	observed flux(Hβ=100) [OIII] 5007	[OI] 6300	[SII] 6716	[SII] 6731	Extn	rf	chart
54C1	12 52 10.1	-76 39 45	1984	12						41.5	587	616	558 e	1.52h	34	3,12
54B	12 52 10.59	-76 40 04.1	1983.26	6	4.0±1.5	-1.1±0.9	6	-41±4	34	>9	460.	366.	371.	1.14h	34	3, 6
54C2	12 52 10.9	-76 39 47	1984	12						41.5	587	616	558 e	1.52h	34	3,12
54J	12 52 11.8	-76 40 00	1984	12												12
54H	12 52 12.1	-76 39 49	1984	12												12
54K	12 52 13.1	-76 40 07	1984	12												12
54E	12 52 13.2	-76 40 05	1984	12				-67±5	34			(p)			3	3,12
54I	12 52 13.7	-76 39 51	1984	12												12
55	15 53 18.7	-37 42 12	1976.26	3				-24±21	L 46	p	120m	100m	150m		55	46
Th28/HHW	16 05 00	-38 56 30		60				+64±	60						60	60
Th28/HHE	16 05 38	-38 54 00		60	(48±3)		60	-26±	60						60	60
56	16 28 54.02	-44 48 36.6	1983.26	6	4.2±3.2	3.5±1.7	6	+36±5	34	49.2	356	259	315	.86h	34	6,64
57	16 28 56.63	-44 49 16.5	1983.26	6	-1.5±1.1	1.1±0.8	6	-59±	24	-	328	328	356	1.23h	34	6,24
M16/HH1	18 16 05.1	-13 53 03	1981.2	36				+10±5 , +90±5	5	67	15	95	146	1.5h	48	5,71
101S	18 58 12.35	-37 07 20.2	1983.26	6	-3.3±	-3.0±	6	-51±9	34						37,	87
101N	18 58 12.51	-37 07 14.4	1983.26	6	-1.0±2.6	-5.8±0.7	6	-89±14	34	16	188	249	292	.76s	45	37,87
96	18 58 18.80	-37 05 10.5	1983.44	87				-52±15	L 87		-	48α	36α		87	87
100	18 58 26.7	-37 02 36	Palomar	66				-139±	66	-	25α	105α	65α		66	37,18
98	18 58 30.42	-37 01 56.5	1983.44	87				+3±15	L 87		31α	35α	44α		87	87
104B	18 58 36.01	-37 01 42.0	1983.26	6	2.6±	8.2±	6	-56±15	L 87		68α	82α	82α		87	6,87
104A	18 58 36.56	-37 01 37.8	1983.26	6	2.3±2.1	2.2±4.5	6	-46±15	L 87		63α	46α	51α		87	6,87
99A	18 58 43.10	-36 59 00.8	1983.26	6	10.8±2.5	7.1±3.6	6	+5±15	L 87		43α	55α	59α		87	37, 6
99B	18 58 43.31	-36 58 56.2	1976.27	13				+14±15	L 87		94α	86α	118α		87	37, 6
32A	19 18 07.91	10 56 21.7	1982.0	7	-3.8±2.1	0.6±1.5	7	+20±4 ,+208±11	c 14	104	682	499	626	1.41s	45	2, 9
32B	19 18 08.19	10 56 17.2	1982.0	7	-13.2±2.5	5.1±1.5	7			48	224	288	275	1.41s	45	2, 9
32C	19 18 09.7	10 56 11		9				-320± , -20±	27			20om	30om		27	9,14
32D	19 18 09.71	10 56 10.4	1982.0	7	-0.3±1.5	-1.8±1.5	7					20om	20om		27	14,27
GN20183/HH1	20 18 21.27	37 00 43.2	1985.8	38				-143±	L 38	310b	60bα	24α	39α		38	38
V645Cyg/HH	21 38 14	50 00 38		58						<73	510	(1480)		.83E	58	58,59
103	21 41 15.8	65 49 55	Palomar	66				-52±15	66	<16	296	382	310	0	26	37,18
GGD32	21 41 17.99	65 50 42.4	Palomar	16				-38±34	28		47α	89α	71α		28	18,28
105	21 42 12.92	65 53 59.6	1983.53	18												18
GGD34	21 42 20.76	65 54 50.3	1983.53	18				-175±37	19	42b	189b	280	230	.46E	52	37,18
GGD35	21 42 33.47	65 54 37.9	Palomar	16				-162±18	26		258	333	254		52	37,18
GGD37A	22 54 03.01	61 46 15.1	1983.53	18												18
GGD37S	22 54 03.03	61 45 57.7	1983.53	18						144	p	p	p		73	18
GGD37H	22 54 03.61	61 45 54.3	1983.53	18							p	p	p		73	18
GGD37B	22 54 03.98	61 46 07.3	1983.53	18												18
GGD37C	22 54 04.35	61 46 04.7	1983.53	18												18
GGD37D	22 54 04.83	61 45 59.5	1983.53	18												18
GGD37G	22 54 05.68	61 46 11.6	1983.53	18												18
GGD37E	22 54 07.39	61 45 56.0	1983.53	18												18
GGD37F	22 54 07.75	61 46 04.7	1983.53	18												18
GGD37HW	22 54 09.95	61 45 42.2	1983.53	18												18

Symbols and Abbreviations to Table I:

α = emission line strength relative to Hα, not Hβ
b = blended with close line, for [OIII] this means λ4959 of the doublet
c = complex velocity substructure
E = E(B–V) reddening
e = quoted line ratios are for the entire HH object (by number) unless listed for only some subset of knots
ESO–B = European Southern Observatory Blue Survey
GGD = Gyulbudaghian, Glushkov, Denisyuk # (see reference 40)
GN = Atlas of Galactic Nebulae # (see reference 38)
h = the reddening constant derived from Hα/Hβ (see references 48, 51)
L = Local Standard of Rest velocity
M = mean radial velocity for the entire named HH object
m = line ratios measured by one of us from the published spectra
o = the reddening parameter C_{SO} derived from [SII] and [OII] (see reference 56)
p = line present
Re = Reipurth # (see reference 15)
S = emission line strengths relative to [SII] λ6730
s = the reddening constant derived from [SII] lines (see reference 45)
sb = substructure
() = two spectral lines added together or combined proper motion (see note following reference 60)
– = line not reported although spectral region observed

TABLE II. — *Some Candidate Herbig Haro objects.*

HH name	R.A. (1950)	Dec.	epoch	rf	chart
13	03 25 44	30 57		17	2
16	03 26 02.8	30 58 52	1946-65	2	2
4	03 26 18.36	31 09 40.2	1982.0	7	37
18B	03 26 20.8	30 57 00	1946-65	2	2
18A	03 26 21.0	30 57 21	1946-65	2	2
30	04 28 43.6	18 06 03	1946-65	2	37
36	05 34 20.7	-06 46 01	1946-65	2	
24D	05 43 36.19	-00 11 00.4	1980.94	69	37,2
22	05 43 40.6	-00 06 37	1983-84	37	37
54Y	12 52 04.0	-76 40 59		12	12
97	18 58 23.30	-37 04 21.3	1983.44	87	87

TABLE III. — *Herbig Haro flows.*

Flow	HH objects	rf	cloud	dist pc	rf	FIR rf	candidate exciting star: Name	rf	R.A. (1950)	Dec.	rf	type	V	K	rf	A_V	rf
HH1/2/3	1,2,3	72	N1999	500	37	77	VLA1	31	05 33 57.0	-06 47 55	31	A		13.8	78	23-63	76
HH3	3	79															
HH5	5	79															
HH7-11	5,7,8,9,10,11	75	N1333	500	37	75	SSV13	72	03 25 58.3	31 05 47	72		23.8	9.3	&a	25	89
HH6	6	82	N1333	500	37		IRAS7	82	03 26 05.2	31 08 14	82						
HH12P	12	75	N1333	500	37	75	SVS16	75	03 25 53.7	31 05 40	75			9.8	89	42	89
HH14P	14	75	N1333	500	37	75	03254+3050	75	03 25 29.9	30 50 31	75						
HH15P	13,15,16	75	N1333	500	37	75	03256+3055	75	03 25 39.2	30 55 20	75						
HH19/24	19,20,24,27?	69	N2068	500	37	75	SSV63	75	05 43 34.7	-00 11 08	72	T		10.5	&b	16	88
HH21	21		N2068	500	37												
HH23P	23?,24jet	69	N2068	500	37												
HH25/26P	25,26	69	N2068	500	37		SSV59	72	05 43 31.2	-00 15 22	72			8.6	72	19	88
HH28/29	28,29	72	L1551	160	17	75	L1551-IRS5	72	04 28 40.2	18 01 41	72			9.4	72	5.9	26
HH31	31	75	B218	140	37	75	HH31-IRS2	75	04 24 53.2	26 12 39	75			10.7	72		
HH32	32	72	L673	300	14	75	AS353A*	72	19 18 09.3	10 56 15	72	T	12.5	7.7	&c		
HH33/40P	33,40	75	L1641	500	37	75	05329-0620	75	05 32 56.1	-06 20 01	75						
HH34	34	29	L1641	500	37		HH34-IRS	29	05 33 03.6	-06 28 49	29	F-K		12.3	29	5	29
HH35	35		N1999	500	37												
HH38/43	38,43	72	L1641	500	37	75	HH43-IRS1	72	05 35 42.1	-07 10 09	75			10.8	72		
HH39	39	72	N2261	800	37	75	R Mon	72	06 36 26.3	08 46 53	72	T		6.3	72		
HH41	41		N1976	500	37												
HH42	42		N1976	500	37												
HH44	44		N1976	500	37												
HH45	45		N1977	500	37												
HH46/47	46,47	13	E2106A	425	13	75	HH46-IRS	75	08 24 16.5	-50 50 43	13	T			55		
HH48	48	75	Cha1	140	12	75	HH48-IRS	75	11 02 59.3	-77 02 01	75	T			55		
HH49/50P	49,50	75	Cha1	140	12	75	11054-7706	75	11 05 28.0	-77 06 32	75						
HH51P	51	75	Cha1	140	12	75	VZ Cha	75	11 07 51.9	-76 07 02	75						
HH52-54P	52,53,54	75	Cha2	140	12	75	12496-7650	75	12 49 38.0	-76 50 44	75						
HH52/53P	52,53	75				75	12515-7641	75	12 51 30.6	-76 41 41	75						
HH54P	54	75				75	12522-7640	75	12 52 12.4	-76 40 01	75						
HH52P	52	12					HH52IRS1	12	12 51 24.3	-76 41 39	12						
HH53P	53	12					HH53*1	12	12 51 37.7	-76 41 11	12						
HH55	55	55	Lup2			75	HH55-IRS	75	15 53 18.7	-37 42 12	75	M3.5 T			55		
HH56	56		Nor1														
HH57	57	13	Nor1	940	41	75	HH57-star	75	16 28 56.9	-44 49 10	13	F8 III	16.3	4.9	41	4.9	41
HH57	57											F FU	16.9	7.6	24		
HH100	99,100,101,104	75	R CrA	130	44		HH100-IRS	55	18 58 28.7	-37 02 33	83	T		7.7	13		
HH102	102		L1551	160	17												
HH103	103		N7129	1000	37												
HH105	105,GGD34	79	N7129	1000	37		Lk Hα 234	79	21 41 57.1	65 53 09	18		12.3	7.4	&d	3-4	18
HH120	120	75	CG30	425	13	75	CG30-IRS4	75	08 07 40.0	-35 56 02	75	K5 III		12.1	30	13	30
DGTau/HH	DGTau/HH	75	Taurus	140	37	75	DGTau	75	04 24 01.0	25 59 35	75	M0-5 T			37	6.0	74
GGD32			N7129	1000	37												
GGD35	GGD35	72	N7129	1000	37												
GGD37	HHA→H,HW,S	73	Cep A	725	73												
GN20183	GN20183/HH1	38		1500	38	75	star 3	38	20 18 21.8	37 00 47	38	B7-9 V			38	11-20	38
M16/HH1			M16	2300	43												
M42/HH	M42/HH1,2,5→10	21	M42	500	37		IRc2	20	05 32 47.0	-05 24 23	91						
M42/HH							IRc9	20	05 32 46.4	-05 23 53	91						
N1555/HH	N1555/HH	75	N1555	140	37	75	T Tau S	75	04 19 04.2	19 25 05	75						
N2023/HH1	N2023/HH1,4,5	10	L1630	450	10		HM49*	10	05 38	-02 18	90		17.7	8.4	&f		
N2023/HH2	N2023HH2,3	10	L1630	450	10												
N2264/HH	see note 25	25	N2264	800	37												
Re4/HH	Re 4 head	75				75	Rei-FIR	75	08 19 28.9	-49 25 12	75						
RNO40	RNO40	74				75	RNO40-FIR	75	05 17 21.7	-05 55 03	74						
RNO43	RNO43	72				75	IRS1-FIR	72	05 29 34.2	12 47 47	74			9.1	72		
RNO43	RNO43	79					unnamed	79	05 29 32.7	12 47 33	79						
Th28/HH	Th28/HHE,W	75	Lup3	140	60	75	Th28	75	16 05 08.3	-38 55 16	75	K? T	16.3		86		
V645Cyg	V645Cyg/HH	58		3500	58		V645Cyg	58	21 38 12	50 00 42	59	A0-5 I	14.1	4.8	&e	2.5	58

Symbols and Abbreviations to Table III:

CG	=	cometary globule
E2106A	=	ESO 210-6A
FU	=	FU Ori type star
GGD	=	Gyulbudaghian, Glushkov, Denisyuk # (see reference 40)
GN	=	Atlas of Galactic Nebulae # (see reference 38)
P	=	possible associations
Re	=	Reipurth # (see reference 15)
T	=	T Tau type star
&a	=	V magnitude from reference 52, K magnitude from reference 72
&b	=	T Tau type from reference 55, K mangnitude from reference 72
&c	=	for a stellar spectrum see reference 27, V magnitude from reference 14, K magnitude from reference 72
&d	=	V magnitude from reference 18, K magnitude from reference 72
&e	=	spectral type and luminosity classification from reference 58, V and K magnitudes from reference 81
&f	=	V magnitude from reference 92, K magnitude from reference 90.
*	=	see cross reference to alternate exciting star names
*AS353A	=	V1352Aql
*HM49	=	Sellgren star C (reference 90)

Notes to Nebulae Names:

Barnard 218 is in the Taurus region
CG30 is in the Gum Nebula
ESO 210-6A is in the Gum Nebula
L1450 is in the same region as N1333
L1551 is a dark cloud in the Taurus region
L1630 contains N2023 and N2024
L1641 is in the same region as N1999
N1555 is in Taurus region
N2068 is a reflection nebula in L1630 which is in M78
N6611 = M16

TABLE IV. — *Cross-references to alternative HH object names.*

HH name used here	Other name(s) and reference
1	Haro 11a (ref. 2)
2	Haro 12a (ref. 2)
3	Haro 10a (ref. 2)
7A	7D (ref. 2)
24A	M78 H-H A (ref. 66)
24B	M78 H-H B (ref. 66)
24Csb	M78 H-H C (ref. 66)
24D	M78 H-H E (ref. 66)
24E	M78 H-H D (ref. 66)
28	LP 415-1166 (ref. 2)
29	LP 415-171 (ref. 2)
40	Haro 9a (ref. 2)
41	Haro 3a (ref. 2)
42	Haro 4a (ref. 2)
43	Haro 14a (ref. 2)
43A	43N (ref. 45)
43B	43C (ref. 45)
43C	43S (ref. 45)
46	46S (ref. 45)
120	R2 = CG30/HH (refs 13, 30)
GGD 32	GM2-32 (ref. 40)
GGD 34	GM2-34 = GM2-34A (refs 28, 40)
GGD 35	GM2-35 (ref. 40)
GM 10A	GM2-10A (ref. 19)
M42/HH3	M42/HHA (ref. 68)
M42/HH4	M42/HHB (ref. 68

Notes and References for Tables I, II, III & IV

1 Herbig: 1974b.
2 Herbig: 1974a. (±0.6–1.8")
3 Schwartz: 1977. (±2") (epochs derived)
4 Zealey, Williams, Sandell: 1984.
5 Meaburn, White: 1982.
6 Schwartz, Jones, Sirk: 1984. (epoch derived for HH 104A,B)
7 Jones: 1983. (gives "HH 4" proper motions as μ_x = 0.8±2.0 "/cen, μ_y = −0.6±2.0 "/cen; "HH 30" proper motions as μ_x = 1.6±0.6 "/cen, μ_y = −2.1±0.9 "/cen)
8 Schwartz, Cohen, Williams: 1987.
9 Zealey, Williams, Taylor, Storey, Sandell: 1986.
10 Malin, Ogura, Walsh: 1987. (proper motion errors approximately 1.5 "/cen)
11 Jones, Cohen, Sirk, Jarrett: 1984. (Dr. Jones, private communication, gives the co-ordinates for RNO 40 as above; this is a correction from that given in his Table 2)
12 Sandell, Zealey, Williams, Taylor, Storey: 1987. ($\pm 0^s.2$, ±5")
13 Cohen, Schwartz, Harvey, Wilking: 1984. (±1.5")
14 Herbig, Jones: 1983. (same astrometrical data as reference 7 but reduced to an earlier epoch) (different velocities from references 45, 70)
15 Reipurth: 1981. (±0.5")
16 Rodriguez, Moran, Ho, Gottlieb: 1980. (±1.0")
17 Edwards, Snell: 1983. (from whose map TVH measured the position given here for HH 13)
18 Hartigan, Lada: 1985. (±1", however reference 79 shows that GGD 34 and HH 105 have complex structure in deep CCD exposures)
19 Magakyan: 1984. (identifies GM 2-10A and GM 2-34A as HH objects)
20 Jones, Walker: 1985.
21 Axon, Taylor: 1984. (±1.5") (spectroscopic data limited as data covered around λ6300 only)
22 Graham, Elias: 1983. (complex velocity substructure) (see also reference 23 for more recent and slightly different spectroscopic data concentrating primarily on HH 47B)
23 Meaburn, Dyson: 1987.
24 Graham, Frogel: 1985. (complex velocity substructure)
25 Adams, Strom, Strom: 1979. (epochs derived) (HH objects are N2264/HH11–6, N2264/HH11–7, N2264/HH14–4, N2264/HH14–5, N2264/HH14–6)
26 Cohen, Fuller: 1985.
27 Hartigan, Mundt, Stocke: 1986.
28 Magakyan: 1983.
29 Reipurth, Bally, Graham, Lane, Zealey: 1986.
30 Pettersson: 1984.
31 Strom, Strom, Grasdalen, Sellgren, Wolff, Morgan, Stocke, Mundt: 1985.
32 Schwartz, Dopita, Cohen: 1985. (indicates the existence of HH 43A,B,C, though does not give co-ordinates)
33 Schwartz: 1978.
34 Schwartz, Dopita: 1980. (see also reference 46 for spectroscopic data on HH 55)

TABLE IV (continued).

35 Canto, Goudis, Johnson, Meaburn: 1980. (from whose photo SJBB measured the position given here for M42/HH2)
36 Meaburn: 1982.
37 Strom, Strom, Wolff, Morgan, Wenz: 1986. (±1.5") (whose objects 17 and 19 are identified with HH 24G1,2)
38 Neckel, Staude: 1987. (epoch derived) (distance between 1000 and 2000 pc)
39 Gyulbudagyan, Magakyan: 1977.
40 Gyulbudaghian, Glushkov, Denisyuk: 1978. (see also reference 42 for an identification of GGD 18 as an HH object)
41 Cohen, Dopita, Schwartz: 1986a. (HH 57 distance based on bolometrically matching observed luminosity of exciting star with FU Ori and V1057 Cyg)
42 Snell: 1983.
43 Goudis: 1976. (distance error approximately 500 parsecs)
44 Marraco, Rydgren: 1981.
45 Dopita: 1978. (see also reference 66 for spectroscopic data on HH 101)
46 Krautter, Reipurth, Eichendorf: 1984.
47 Jones, Herbig: 1982. (from whose photo TVH measured the position given here for HH 39B)
48 Meaburn, Walsh: 1984. (see also reference 46 for spectroscopic data on M16/HH1)
49 Elias: 1978. (±1")
50 Böhm, Perry, Schwartz: 1973.
51 Dopita, Schwartz, Evans: 1982. (indicates a possible HH object, 47D, though no co-ordinates given)
52 Goodrich: 1986a. (see also references 11 for spectroscopic data on RNO 40; 45, 57 on HH 40 and 26 on GGD 35)
53 Graham: 1986. (see also reference 23 for spectroscopic data on HH 46 and HH 47)
54 Münch: 1977. (identifies M42/HH1A and B as separate in radial velocity and line strengths, other information repeated for the two objects)
55 Cohen, Dopita, Schwartz: 1986b.
56 Dopita, Binette, Schwartz: 1982.
57 Brugel, Böhm, Mannery: 1981. (see also reference 66 for spectroscopic data on HH 7)
58 Goodrich: 1986b. (from whose map TVH measured the position given here for TH28/HHE,W relative to V645 Cygni, which has co-ordinates given by reference 59)
59 Cohen: 1977.
60 Krautter: 1986. (from whose photo TVH measured the positions given here relative to Th 28, which has co-ordinates given by reference 3) (the proper motion for Th28/HHE is the total proper motion – the square root of the sum of the squares of the R.A. and Dec. proper motions)
61 Schwartz: 1975. (Schwartz's "Faint Emission Nebula" at 30"W position is at, or just south of, NGC1555/HH)
62 Meaburn: 1986.
63 Reipurth: 1985α
64 Reipurth: 1985b.
65 Herbig, Jones: 1981.
66 Strom, Grasdalen, Strom: 1974. (unlisted velocity errors are approx 15 km/s)
67 Mundt, Bührke, Fried, Neckel, Sarcander, Stocke: 1984.
68 Walsh: 1982. (from whose photo SJBB measured the positions given here for M42/HH3,4)
69 Jones, Cohen, Wehinger, Gehren: 1987 (from whose figure PMW measured the position given here for HH 24G3) (motions measured relative to 7 dark cloud member stars) (velocity errors about 20 to 40 km/s) (spectroscopic data from strongest subknot of object: 25B for HH 25, 26B for HH 26, 27C for HH 27)
70 Mundt, Stocke, Stockman: 1983.
71 Meaburn, Walsh: 1986.
72 Cohen, Schwartz: 1983.
73 Hartigan, Lada, Stocke, Tapia: 1986. (from whose map TVH measured the position given here for the GGD 37 exciting star)
74 Cohen, Harvey, Schwartz: 1985b.
75 Cohen, Schwartz: 1987.
76 Tapia, Roth, Carrasco, Ruiz: 1987.
77 Pravdo, Chester: 1987.
78 Harvey, Joy, Lester, Wilking: 1986.
79 Ray: 1987.
80 Bechis, Harvey, Campbell, Hoffmann: 1978.
81 Humphreys, Merrill, Black: 1980. (finds V645Cyg exciting star is B8 V with absorption 1.2e)
82 Knee, Liseau, Sandell, Zealey: 1987.
83 Reipurth, Wamsteker: 1983. (also indicates K and other band variability for HH100-IRS)
84 Mundt, Fried: 1983. (from whose photo TVH measured the position given here for DGTau/HH relative to DGTau, which has co-ordinates given by reference 75)
85 (position measured by TVH against 9 reference stars using a measuring machine accurate to 10 microns)
86 Appenzeller, Jankovics, Krautter: 1983.
87 Hartigan, Graham: 1987. (also discusses greater substructure in HH 101)
88 Strom, Strom, Vrba: 1976.
89 Strom, Vrba, Strom: 1976.
90 Sellgren: 1983.
91 Downes, Genzel, Becklin, Wynn-Williams: 1981
92 Witt, Schild, Kraiman: 1984.