New Planetary Nebulae and Candidates from Multicolour Multiwavelength surveys

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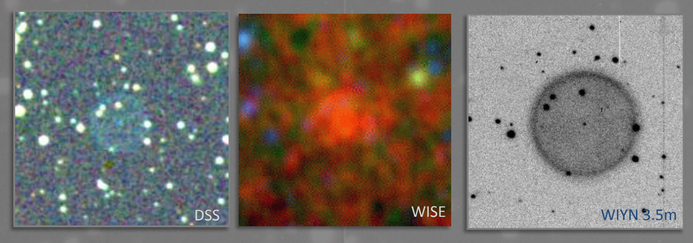
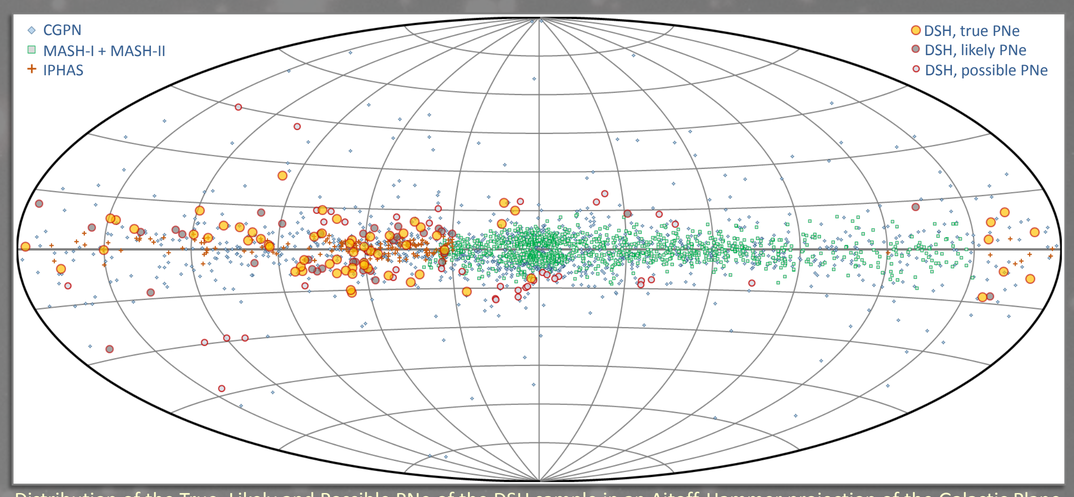
Introduction

During the past decade, the Deep Sky Hunters (DSH) [1,6] and other pro-am collaborations [2] have been searching for unidentified planetary nebulae (PNe) by scanning multicolour images of the Digitized Sky Survey (DSS) and other publicly available digital resources (SDSS, GALEX, WISE), or by inspecting [S II]/H_α/[O III] narrowband images of the Milky Way taken with modern CCD cameras.



Identification of PN candidates outside of the MASH and IPHAS survey regions (object: Pa 9 [6,7]). Left: False-colour image generated from DSS-II images taken in the blue, red and near-IR. Mid: WISE multi-colour image (R: 4.8um; G: 12um; B: 22um). Right: H_α + [NII] image.

Thus far, 210 PN candidates were identified in a region of ≈5000°. More than 80% of these were found in fields complementary to those covered by the H_α surveys that were conducted recently at INT (IPHAS [3]; |b| < 5°) and AAO/UKST (SHS [4]; |b| < 10°) for the northern and southern Galactic Plane and that have led to the discovery of about half of the ≈3000 Galactic PNe that are known to date [5].



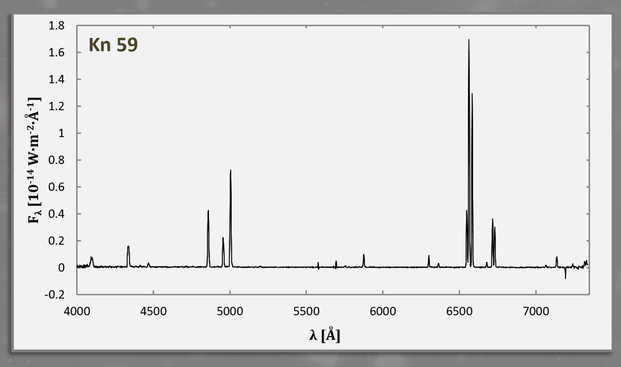
Distribution of the True, Likely and Possible PNe of the DSH sample in an Aitoff-Hammer projection of the Galactic Plane. Objects listed in the CGPN [8] and the MASH-I [9], MASH-II [10] and IPHAS [11] catalogues are shown for comparison.

Current status

More than 150 objects from our initial target list were imaged so far during several observing campaigns at SPM, KPNO, OHP and other facilities using H_α and [O III] narrowband filters. Of these, 106 were considered possible or likely PNe, with a considerably high fraction of spherical shells (≈ 20%). Subsequent spectroscopic observations of 73 of the 106 objects demonstrated that 64 are true PNe. This gives a success rate of more than 60% for discovering a PN with our technique, starting mostly from available broadband data.

New spectroscopically confirmed PNe from [6,7]

ID	PN G	RA J2000	DE J2000	size arcsec	instrument
Kn 33	147.2+08.3	04:32:38.1	+60:20:12	17 x 16	SPM 2.1-m
Kn 39	197.2+10.0	06:59:23.8	+18:26:49	111 x 102	SPM 2.1-m
Kn 60	202.9+07.4	07:00:06.7	+12:14:40	5 x 5	SAAO 1.9-m
Kn 42	012.8+09.6	17:38:44.7	−12:57:20	11 x 10	SPM 2.1-m
Kn 59	095.2+25.4	18:41:41.9	+65:11:58	> 4 x 4	SPM 2.1-m
Kn 61	070.5+11.0	19:21:38.9	+38:18:57	100 x 92	SPM 2.1-m
Kn 8	058.2+04.5	19:22:38.8	+24:33:02	68 x 53	SPM 2.1-m
Kn 56	025.4-16.4	19:37:43.8	−13:51:20	40 x 25	SAAO 1.9-m
Kn 20	069.7-03.7	20:21:26.5	+30:05:39	15 x 15	SPM 2.1-m
Kn 19	066.9-07.8	20:29:20.6	+25:32:40	74 x 73	SPM 2.1-m
Kn 24	082.1-07.8	21:13:37.7	+37:15:38	190 x 190	SPM 2.1-m
Kn 30	103.7+07.2	21:47:24.3	+63:05:09	13 x 12	SPM 2.1-m



Broadband spectrum of the confirmed PN Kn 59 (SPM 2.1-m, Boller & Chivens Spectrograph).

New PN candidates

In the past two years, additional 37 PN candidates have been identified as previously unknown possible and likely PNe. Many of the new candidates were discovered on mid-IR imagery provided by the Wide-Field Infrared Survey Explorer (WISE), including several objects located within the IPHAS and SHS survey areas that are too faint to be shown on the survey images. The objects **Pa 13, Pa 14** and **Pa 15** have already been confirmed as True PNe from broadband spectra taken with the SPM 2.1-m telescope.

New PN candidates

ID	RA J2000	DE J2000	size arcsec	type	notes
Pa 30	00:53:11.3	+67:30:02	171 x 156	L	
Pa 31	01:21:42.5	+68:47:11	35 x 28	L	
Pa 32	03:11:05.3	+63:50:15	73 x 60	L	
Kn 67	03:32:15.0	+21:39:43	5.5 x 5.2	L	(1)
Kn 51	04:25:25.5	+35:06:13	219 x 150	P	
Kn 63	05:42:06.7	+04:43:04	388 x 358	L	(2)
Kn 62	06:23:55.4	+38:15:15	126 x 126	L	
AlvKn 1	08:04:04.4	-06:30:57	1100 x 1060	P	(3)
Pa 33	15:11:13.9	-42:10:23	175 x 165	L	
Pa 34	18:25:15.3	+00:02:04	31 x 26	L	
Pa 16	18:26:35.0	+04:59:06	57 x 46	L	
Pa 17	18:29:10.2	+03:39:50	39 x 36	L	
Pa 18	18:42:01.2	+08:46:24	32 x 31	L	
Kn 66	18:49:54.9	+17:57:15	< 3 x 3	L	
Pa 35	18:56:55.4	-01:03:51	8 x 8	L	
Pa 19	19:05:08.7	+16:15:21	35 x 32	L	(4)
Pa 20	19:07:31.8	+24:59:58	17 x 17	L	
Pa 36	19:10:09.1	-01:52:29	< 4 x 4	L	
Kn 65	19:10:51.5	-09:16:49	60 x 54	P	
Li 1	19:12:10.4	+16:46:36	6 x 6	L	(5)
Pa 37	19:19:29.4	-02:30:01	37 x 31	P	
Pa 21	19:23:15.1	+27:07:34	4 x 2	L	
Pa 13	**19:41:21.0**	**+03:07:17**	**29 x 27**	**T**	
Mul 1	19:44:22.0	+16:55:35	156 x 114	P	(6)
Pa 14	**19:56:51.5**	**+39:43:10**	**17 x 16**	**T**	
Pa 22	19:58:13.1	+39:54:41	49 x 45	L	
Pa 23	20:10:21.5	+18:11:50	16 x 11	L	
Pa 24	20:11:44.4	+24:50:06	42 x 39	L	
Pa 25	20:15:01.8	+20:25:21	9 x 9	L	
Pa 26	20:19:46.2	+15:14:07	15 x 11	L	
Pa 39	20:25:34.6	+53:12:44	30 x 25	L	
Pa 15	**20:29:07.6**	**+23:11:09**	**16 x 16**	**T**	
Pa 27	20:48:58.2	+32:18:16	67 x 64	L	(7)
Zol 1	20:53:49.6	+46:46:47	36 x 36	L	(8)
Pa 28	20:58:11.0	+33:08:33	133 x 123	L	
Pa 29	20:59:43.5	+34:54:23	4 x 4	L	
Pa 41	22:10:13.7	+50:04:33	154 x 136	P	

Yellow: spectroscopically confirmed PNe

Type: T … true PN L … Likely PN P … Possible PN

Notes: (1) Halo PN? (2) "Medallion Nebula" (3) = Fr 2-25 [12] (4) NW of IPHASX J190512.4+161347 (5) = IPHASX J191210.4+164636 (6) = IPHASX J194422.0+165535 (7) super-imposed on SNR filament (8) = IPHASX J205349.6+464647

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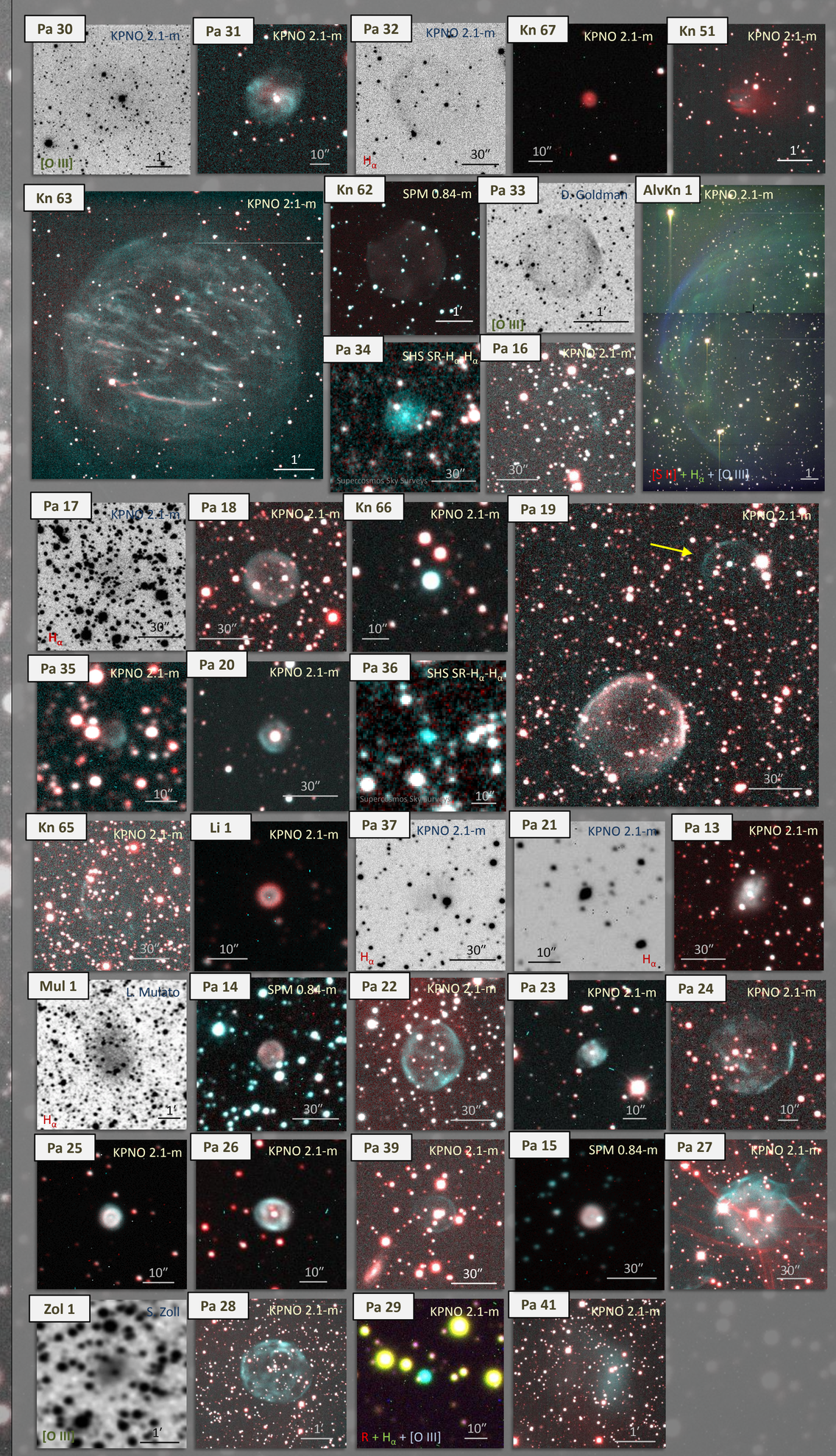
Narrowband images of new PN candidates



Narrowband images of newly identified PN candidates. Unless otherwise noted, R = H_α, G,B = [O III].