Characterization of (binary) central stars of planetary nebulae

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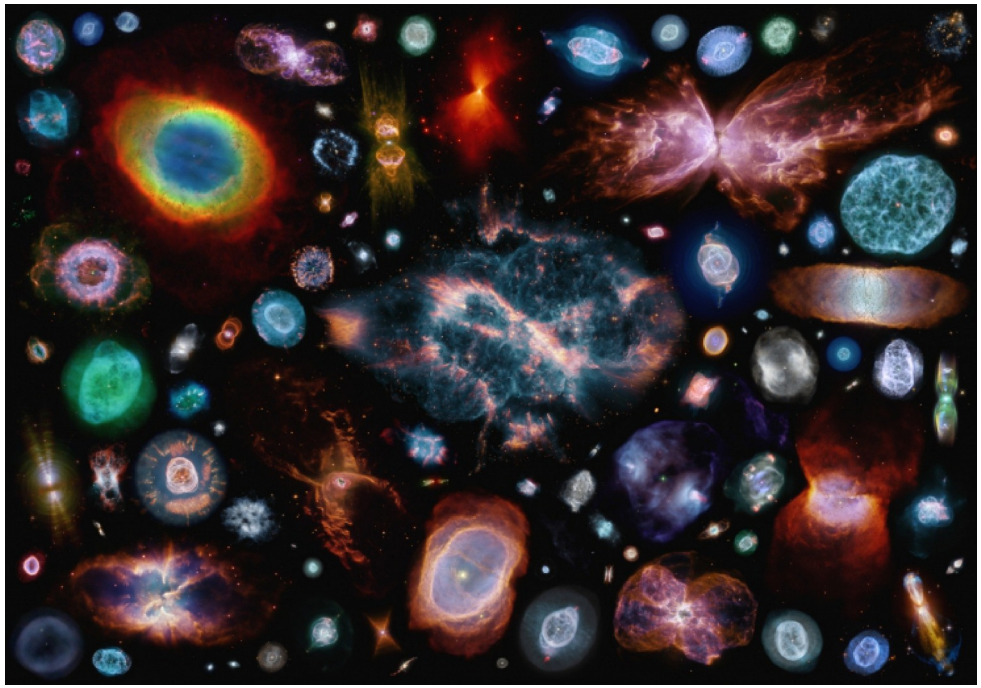
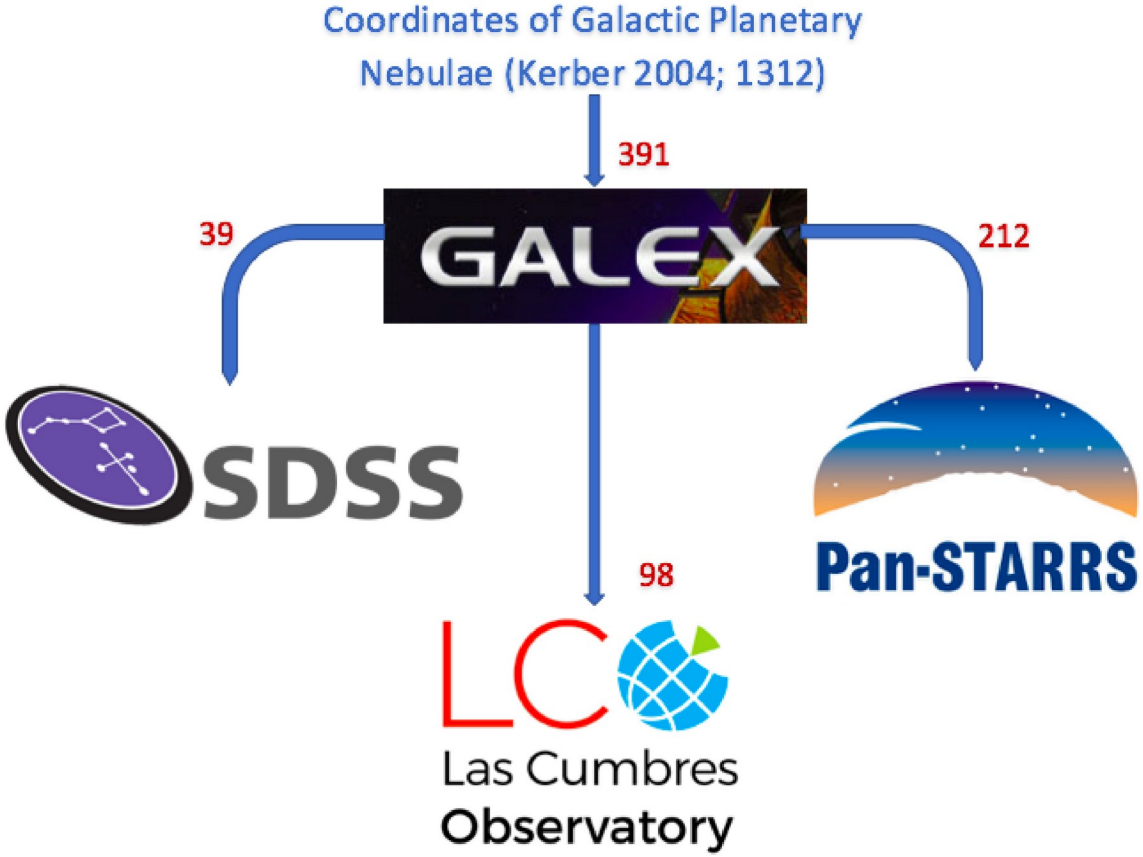
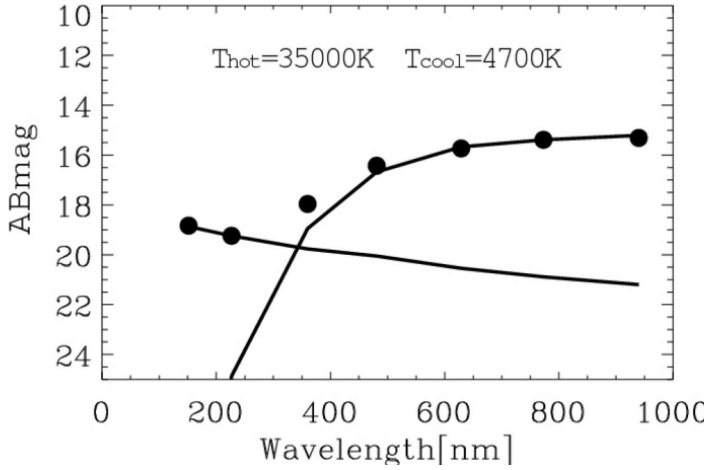
Introduction



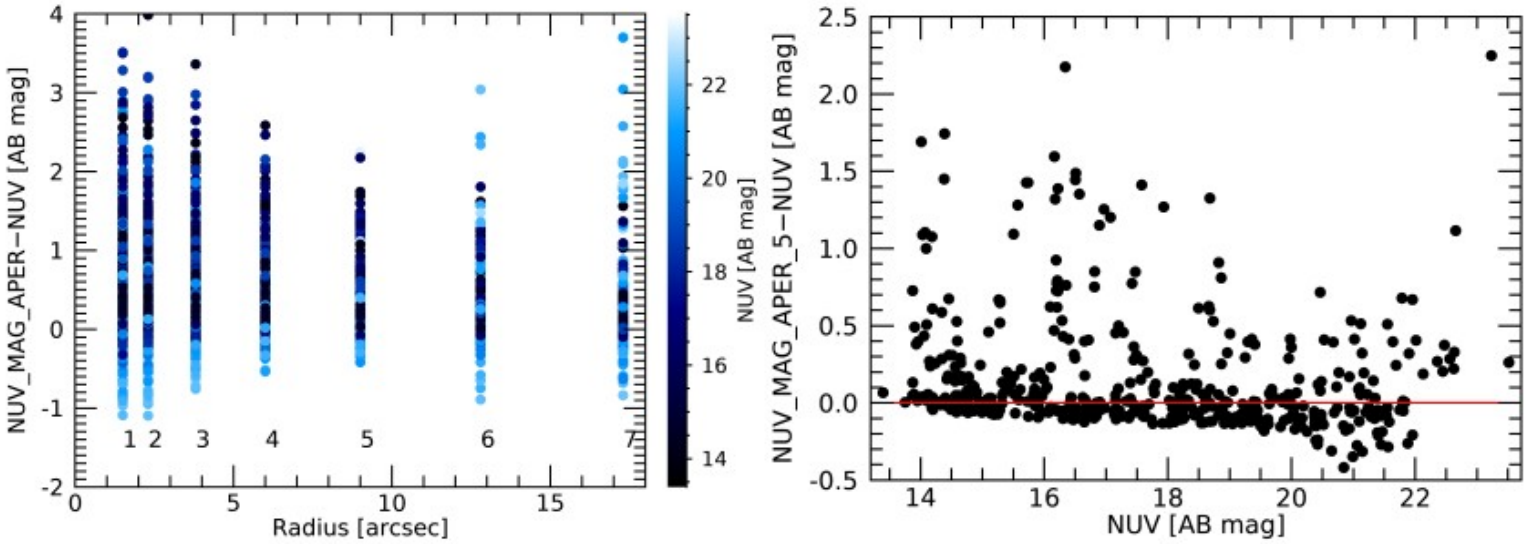
- The majority of stars (initial mass ≤8 M) end their live as white dwarfs, after loosing most of their initial mass during the AGB phase. During a brief post-AGB phase, a planetary Nebula (PN) is formed, which contains the imprint of the previously expelled layers.
- Most of them show asymmetrical morphology.
- Binary stars are thought to be the preferred scenario for the formation of bipolar PNe.

PNe found in UV and optical corollary surveys



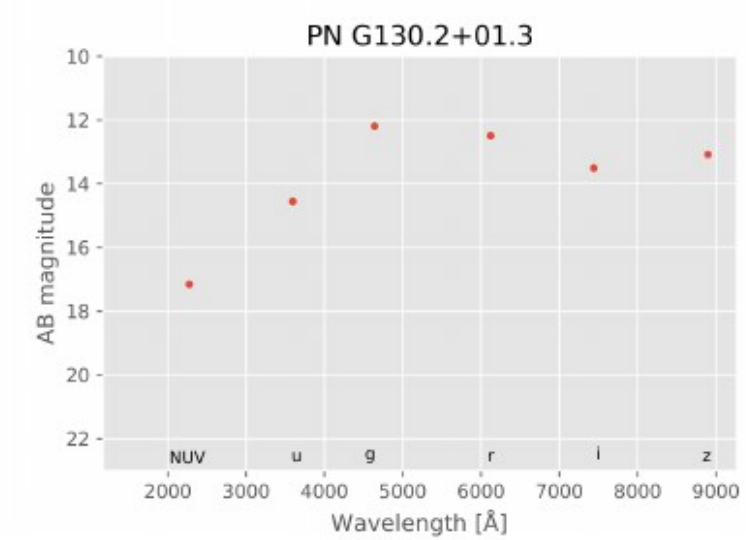


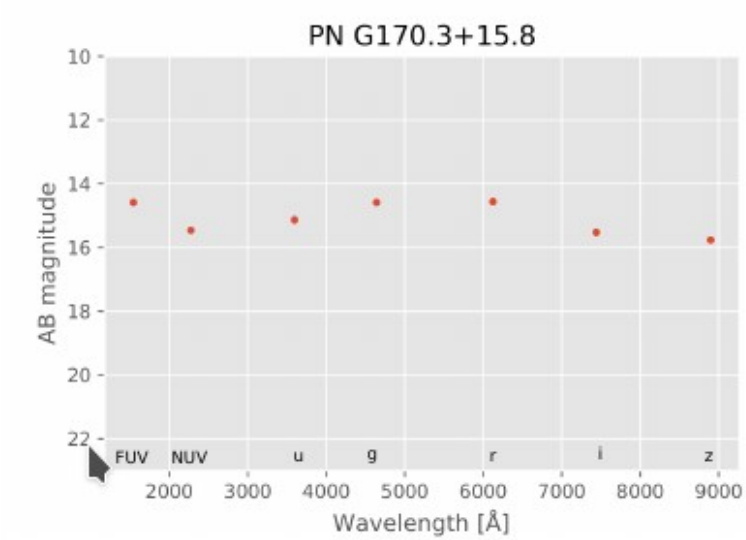
- We made a curve-of-growth analysis of each of the extended PNe.
- The CS flux was isolated from the nebular emission for extended PNe. Circular aperture was used for the CS and an annulus for local background substraction.
- Photometry were re-calculated.



Determination of T_{eff}, α, and β

- Therefore, we constructed the SEDs for each extracted CSPNe.
- For a binary CS, a double SED feature is expected.

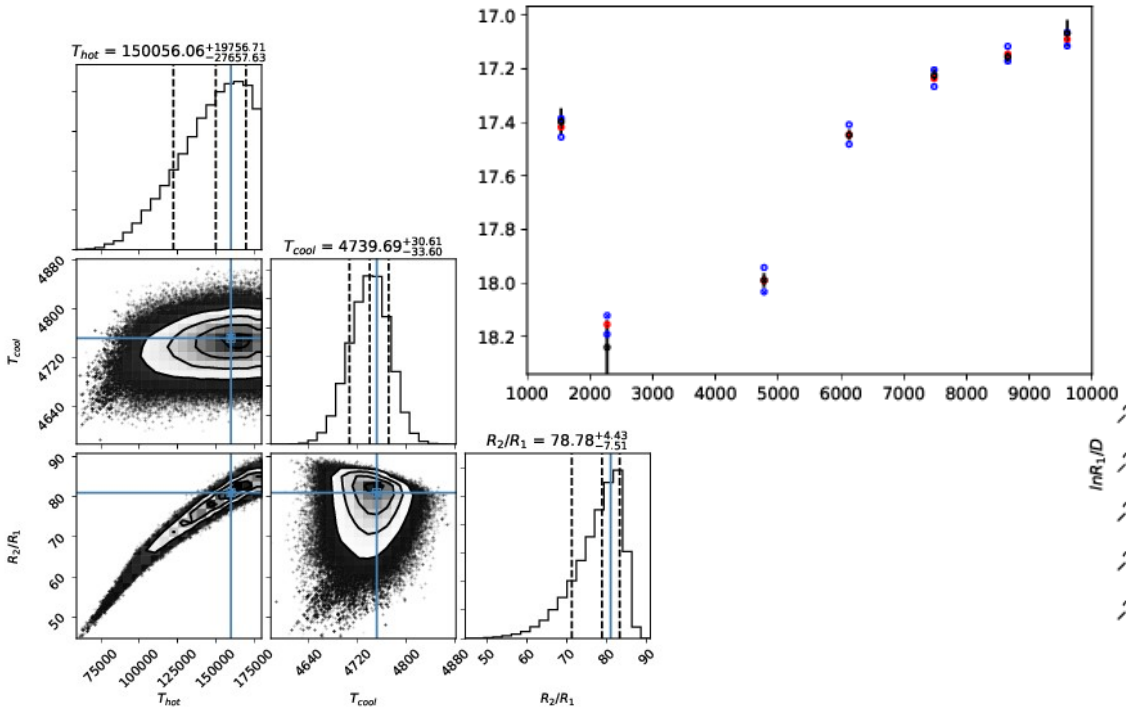


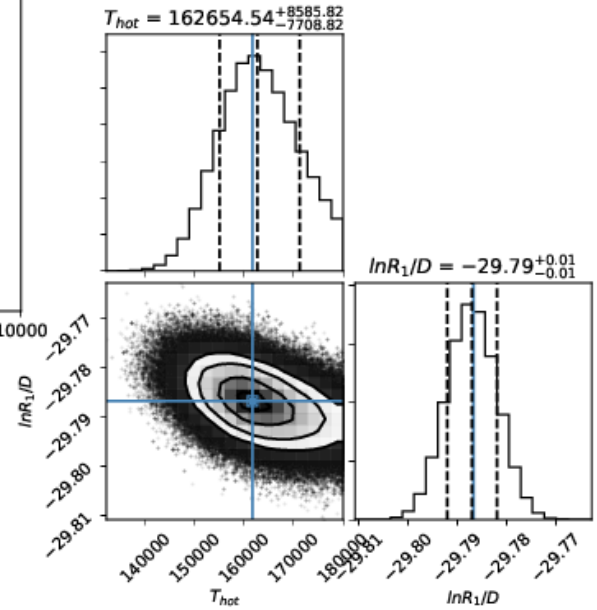


– The fitting process

$$m_i - m_{i-1} = -2.5\log\left(\frac{f_\nu^{hot} + f_\nu^{cool}\alpha}{f_\nu^{hot} + f_\nu^{cool}\alpha}\right)$$

$$mAB = -2.5\log([f_\nu^{hot} + f_\nu^{cool}\alpha]\beta) - 48.6.$$



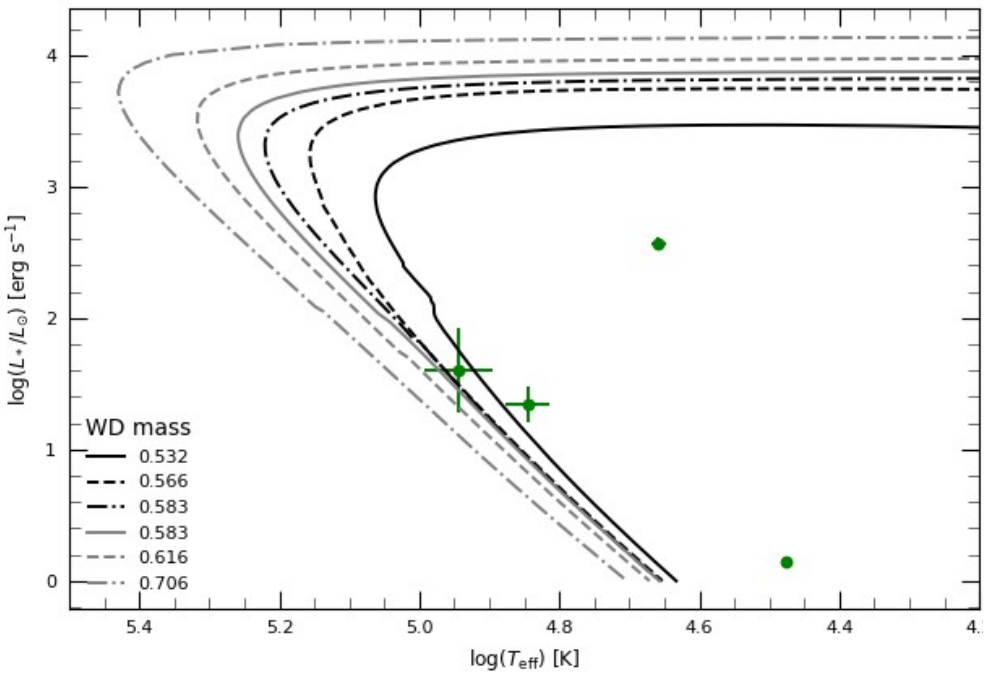


PNe with Gaia DR2 distances

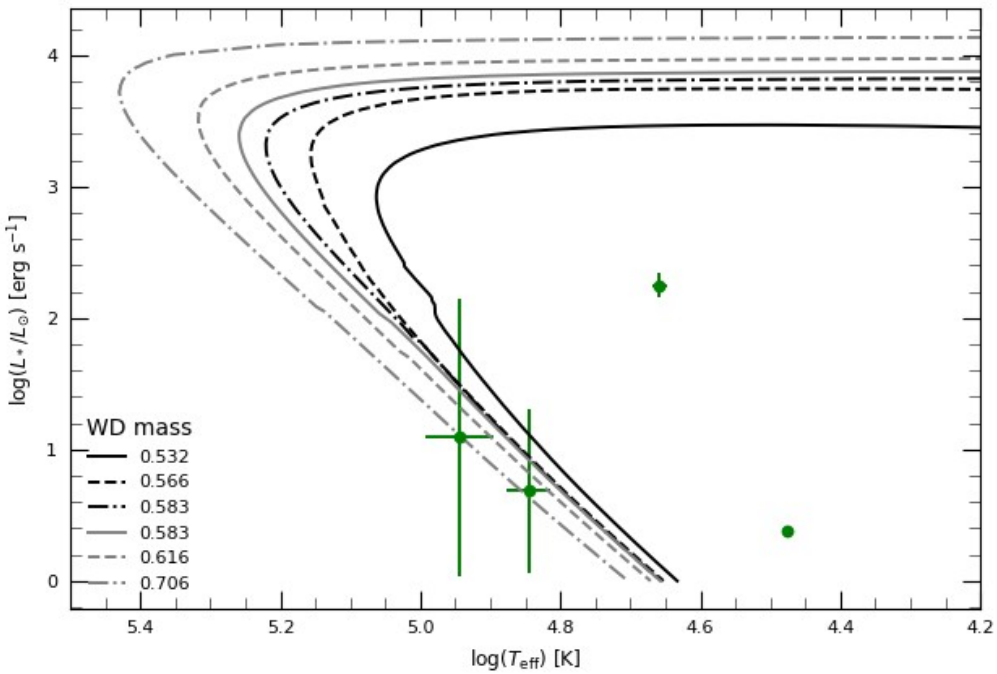
PNG	$E(B-V)^a$	$T_{\rm hot}$	$T_{\rm cool}$	$R_{\rm hot}$	$R_{\rm cool}$	D	$L_{\rm hot}$	$L_{\rm cool}$	Refs.[b]
	(mag)	(10^3 K)		($R_\odot$)		(pc)	($L_\odot$)		
047.0+42.4	0.0800	62.3±1.7		0.0671±0.0007		984±6	60.02±6.8		
059.7−18.7	0.0652	77.5±7.0		0.0685±0.0007		1395±15	152.35±50.0		
077.6+14.7	0.0589	113.2±8.0		0.0319±0.0023		1635±13	151.20±40.0		
104.2−29.6	0.0835	106.0±8.0		0.0315±0.0029		808±8	112.87±30.0		
144.5+06.5[c]	0.5247	45.5±1.2	8.2±0.1	0.3084±0.0138	1.4434±0.2204	1679±74	368.44±36.9	89.74±4.5	
164.8+31.1	0.0100	88.0:	<3000	0.0256		979.2±97	40±30.0		
205.1+14.2	0.0419	45.5±3.0		0.0331±0.0016		530.6±24	4.23±1.3		1
217.1+14.7	0.0279	102.9±7.0		0.0146±0.0015		691.2±69	21.66±6.5		
219.1+31.2	0.0400	70.0±5.0	2.7±0.2	0.0321±0.0019	0.3585±0.0321	504±23	22.24±7.0	0.006±0.002	
326.7+42.2	0.1000	30.0±0.3	5.0±0.1	0.0437±0.0100	1.04±0.5	1867±429	1.39±0.06	0.61±0.7	

– H-R diagrams

Gaia DR2 distances.



Literature distances.



What we expect for DR3?

PNG	$E(B-V)^a$	$T_{\rm hot}$	$T_{\rm cool}$	$\ln(\alpha)$	β	Refs.[b]
	(mag)	(K)				
003.3+66.1	0.00±0.06	100 000±2500	4245.89±90.0	−28.92±0.01	10.37±0.50	1
019.8−23.7	0.1625	63 084±1900	7945.00±300.0	−28.29±0.01	1.87±0.09	
038.1−25.4	0.0479	>195 000	4905.37±30.0	−29.98±0.04	89.57±4.00	2
117.5+18.9	0.1208	150 000:		−29.15±0.13		
144.3−15.5	0.0852	191 500±3500	4068.37±50.0	−29.86±0.01	27.87±1.10	
153.7+22.8	0.13±0.03	45 660±900	3804.86±400.0	−28.39±0.01	5.89±1.00	3
171.3−25.8	0.1000	30 000±100	8000.00±300.0	−28.31±0.01	7.28±2.00	
211.4+18.4	0.0000	85 500.±9500		−28.52±0.10		1
270.1+24.8	0.0454	81 642±2200	4000.00±700.0	−27.79±0.02	2.33±0.60	
283.6+25.3	0.1027	>195 000:	4868.64±300.0	−28.23±0.02	31.84±5.00	4
286.8−29.5	0.0520	106 700:	4680.70±1000.0	−27.81±0.10	7.28±3.0	5
291.4+19.2	0.1488	68 808±6000	4658.83±500.0	−27.70±0.04	7.24±1.80	

Concluding remarks

- More than 200 PNe were found in UV and optical corollary surveys.
- Only 50 PNe are extended enough to isolating the CS flux from nebular emission (nebular continuum and emission lines).
- Effective temperatures and scale factors were obtained by using a statistical method by comparing synthetic spectra for both hot and cool star with observations.
- Gaia DR2 distances were used to estimate the stellar parameters and luminosities for our samples. A total of 4 PNe have accurate parallaxes.
- Gaia DR2 accurate distances changes the distribution on the H-R diagram of 2 PNe.