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A revised catalogue of 294 Galactic supernova remnants

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Abstract. A revised catalogue of Galactic supernova remnants (SNRs) is presented, along with some simple statistics of their properties. Six new SNRs have been added to the catalogue since the previous published version from 2014, and six entries have been removed, as they have been identified as H II regions, leaving the number of entries in the catalogue at 294. Some simple statistics of the remnants in the catalogue, and the selection effects that apply, are discussed, along with some recently proposed Galactic SNR candidates.

Keywords. Supernova remnants—catalogues—ISM: general.

1. Introduction

This paper presents the latest version of a catalogue of Galactic supernova remnants (SNRs) which I have compiled for several decades. Previous versions have been published in Green (1984, 1988, 1991, 2004, 2009, 2014) and Stephenson & Green (2002). In addition, more detailed web-based versions of the catalogue have been produced since 1995 – most recently in 2017 – which either correspond to one of the published catalogues, or are an intermediate revision. This version of the catalogue contains 294 entries. Section 2 gives the details of the entries in the catalogue, and Section 3 discusses the entries added or removed from the catalogue since the last published version (Green 2014). Section 4 discusses some simple statistics of the remnants in the current catalogue, the selection effects that apply to the identification of Galactic SNRs, and some recently proposed candidate SNRs.

2. The catalogue format

This catalogue is based on the literature published up to the end of 2018, and contains 294 entries. For each SNR in the catalogue, the following parameters are given:

- *Galactic coordinates of the remnant*. These are quoted to a tenth of a degree, as is conventional. In this catalogue additional leading zeros are not used. These are generally taken from the Galactic coordinate based name used for the remnant in the literature. It should be noted that when these names were first defined, they may not have followed the IAU recommendation[1] that coordinates should be truncated, not rounded to construct such names.
- *Right ascension and declination*. The right ascension and declination of J2000.0 equatorial coordinates of the source centroid, for which an accuracy of the quoted values depends on the size of the remnant. For small remnants, they are to the nearest few seconds of time and the nearest minute of arc respectively, whereas for larger remnants they are rounded to coarser values, but are in every case sufficient to specify a point within the boundary of the remnant. These coordinates are usually deduced from radio images rather than from X-ray or optical observations.
- *Angular size*. The angular size of the remnant in arcminutes. This is usually taken from the highest resolution radio image available. The boundary of most remnants approximates reasonably well to either a circle or to an ellipse. A single value is quoted for the angular size of the more nearly circular remnants, which is the diameter of a circle with an area equal to that of the remnant. For more elongated remnants, the product of two values is

[1] See, http://cdsweb.u-strasbg.fr/Dic/iau-spec.htx.

given, which are the major and minor diameters of the remnant boundary modelled as an ellipse. In a small number of cases an ellipse is not a good description of the boundary of the object (which will be noted in the description of the object given in its catalogue entry), although an angular size is still quoted for information. For ‘filled-centre’ type remnants (see below), the size quoted is for the largest extent of the observed emission, not, as at times has been used by others, the half-width of the centrally brightened peak.

- *Type of the SNR*. This is ‘S’ or ‘F’ if the remnant shows a ‘shell’ or ‘filled-centre’ structure, or ‘C’ if it shows ‘composite’ (or ‘combination’) radio structure, with a combination of shell and filled-centre characteristics. If there is some uncertainty, the type is given as ‘S?’, ‘F?’ or ‘C?’, and as ‘?’ in several cases where an object is conventionally regarded as an SNR even though its nature is poorly known or it is not well-understood. (Note: the term ‘composite’ has been used, by some authors, in a different sense, to describe remnants with radio shell and centrally-brightened X-ray emission. An alternative term used to describe such remnants is ‘mixed morphology’, e.g. see Rho & Petre 1998.)
- *Flux density*. The flux density of the remnant at a frequency of 1 GHz, in jansky. This is *not* a measured value, but is instead derived from the observed radio spectrum of the source. The frequency of 1 GHz is chosen because flux density measurements are usually available at both higher and lower frequencies. Some young remnants – notably G111.7−2.1 (=Cassiopeia A) and G184.6−5.8 (=Crab Nebula), but also G130.7+3.1 (=3C58) and G120.1+1.4 (=Tycho) – show secular variations in their radio flux density. In this revision of the catalogue, the 1-GHz flux densities for G111.7−2.1 and G184.6−5.8 have been taken from Perley and Butler (2017), for an epoch of 2016. Results from the primary literature should be used for any detailed quantitative studies of the radio spectra of these and other remnants.
- *Spectral index*. The spectral index of the integrated radio emission from the remnant, α (here defined in the sense, $S \propto \nu^{-\alpha}$, where S is the flux density at frequency ν). This is either a value that is quoted in the literature, or one deduced from the available integrated flux densities of the remnant. For several SNRs a simple power law is not adequate to describe their radio spectra, either because there is evidence that the integrated spectrum is curved or the spectral index varies across the face of the remnant. In these cases the spectral index is given as ‘varies’ (refer to the description of the remnant and appropriate references in the detailed catalogue entry for more information). In some cases, for example where the remnant is highly confused with thermal emission, the spectral index is given as ‘?’ since no value can be deduced with any confidence. These spectral indices have a very wide range of quality, and the primary literature should be consulted for any detailed study of the radio spectral indices of these remnants.
- *Other names that are commonly used for the remnant*. Note that these are given in parentheses if the remnant is only a part of the source. For some well-known remnants – e.g. G184.6−5.8, the Crab Nebula – not all common names are given.

A summary of the data available for all 294 remnants in the catalogue is given in Table 1.

A more detailed version of the catalogue is available at http://www.mrao.cam.ac.uk/surveys/snrs/. In addition to the basic parameters which are given in Table 1, the detailed catalogue contains the following additional information.

(i) Notes on the remnant. For example, if other Galactic coordinates have at times been used to label it (usually before good observations have revealed the full extent of the object, but sometimes in error); if the SNR is thought to be the remnant of a historical SN.
(ii) Short descriptions of the observed structure/properties of the remnant at radio, optical and X-ray wavelengths, as appropriate from available observations.
(iii) Comments on distance determinations, and any point sources or pulsars in or near the object (although they may not necessarily be related to the remnant).
(iv) References to observations are given for each remnant, complete with journal, volume, page, and a short description of what information each paper contains (e.g. for radio observations these generally include the telescopes used, the observing frequencies and resolutions, together with any flux density determinations). These references are *not* complete, but cover recent and representative observations of the remnant that

Table 1. 294 Galactic supernova remnants: summary data.

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
0.0	+0.0	17 45 44	−29 00	3.5×2.5	S	100?	0.8?	Sgr A East
0.3	+0.0	17 46 15	−28 38	15×8	S	22	0.6	
0.9	+0.1	17 47 21	−28 09	8	C	18?	varies	
1.0	−0.1	17 48 30	−28 09	8	S	15	0.6?	
1.4	−0.1	17 49 39	−27 46	10	S	2?	?	
1.9	+0.3	17 48 45	−27 10	1.5	S	0.6	0.6	
3.7	−0.2	17 55 26	−25 50	14×11	S	2.3	0.65	
3.8	+0.3	17 52 55	−25 28	18	S?	3?	0.6	
4.2	−3.5	18 08 55	−27 03	28	S	3.2?	0.6?	
4.5	+6.8	17 30 42	−21 29	3	S	19	0.64	Kepler, SN1604, 3C358
4.8	+6.2	17 33 25	−21 34	18	S	3	0.6	
5.2	−2.6	18 07 30	−25 45	18	S	2.6?	0.6?	
5.4	−1.2	18 02 10	−24 54	35	C?	35?	0.2?	Milne 56
5.5	+0.3	17 57 04	−24 00	15×12	S	5.5	0.7	
5.9	+3.1	17 47 20	−22 16	20	S	3.3?	0.4?	
6.1	+0.5	17 57 29	−23 25	18×12	S	4.5	0.9	
6.1	+1.2	17 54 55	−23 05	30×26	F	4.0?	0.3?	
6.4	−0.1	18 00 30	−23 26	48	C	310	varies	W28
6.4	+4.0	17 45 10	−21 22	31	S	1.3?	0.4?	
6.5	−0.4	18 02 11	−23 34	18	S	27	0.6	
7.0	−0.1	18 01 50	−22 54	15	S	2.5?	0.5?	
7.2	+0.2	18 01 07	−22 38	12	S	2.8	0.6	
7.7	−3.7	18 17 25	−24 04	22	S	11	0.32	1814−24
8.3	−0.0	18 04 34	−21 49	5×4	S	1.2	0.6	
8.7	−5.0	18 24 10	−23 48	26	S	4.4	0.3	
8.7	−0.1	18 05 30	−21 26	45	S?	80	0.5	(W30)
8.9	+0.4	18 03 58	−21 03	24	S	9	0.6	
9.7	−0.0	18 07 22	−20 35	15×11	S	3.7	0.6	
9.8	+0.6	18 05 08	−20 14	12	S	3.9	0.5	
9.9	−0.8	18 10 41	−20 43	12	S	6.7	0.4	
10.5	−0.0	18 09 08	−19 47	6	S	0.9	0.6	
11.0	−0.0	18 10 04	−19 25	11×9	S	1.3	0.6	
11.1	−1.0	18 14 03	−19 46	18×12	S	5.8	0.5	
11.1	−0.7	18 12 46	−19 38	11×7	S	1.0	0.7	
11.1	+0.1	18 09 47	−19 12	12×10	S	2.3	0.4	
11.2	−0.3	18 11 27	−19 25	4	C	22	0.5	
11.4	−0.1	18 10 47	−19 05	8	S?	6	0.5	
11.8	−0.2	18 12 25	−18 44	4	S	0.7	0.3	
12.0	−0.1	18 12 11	−18 37	7?	?	3.5	0.7	
12.2	+0.3	18 11 17	−18 10	6×5	S	0.8	0.7	
12.5	+0.2	18 12 14	−17 55	6×5	C?	0.6	0.4	
12.7	−0.0	18 13 19	−17 54	6	S	0.8	0.8	
12.8	−0.0	18 13 37	−17 49	3	C?	0.8	0.5	
13.3	−1.3	18 19 20	−18 00	70×40	S?	?	?	
13.5	+0.2	18 14 14	−17 12	5×4	S	3.5?	1.0?	

Table 1. *Continued.*

l /°	*b* /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
14.1	−0.1	18 16 40	−16 41	6×5	S	0.5	0.6	
14.3	+0.1	18 15 58	−16 27	5×4	S	0.6	0.4	
15.1	−1.6	18 24 00	−16 34	30×24	S?	5.5?	0.0?	
15.4	+0.1	18 18 02	−15 27	15×14	C?	5.6	0.62	
15.9	+0.2	18 18 52	−15 02	7×5	S?	5.0	0.63	
16.0	−0.5	18 21 56	−15 14	15×10	S	2.7	0.6	
16.2	−2.7	18 29 40	−16 08	17	S	2.5	0.4	
16.4	−0.5	18 22 38	−14 55	13	S	4.6	0.3?	
16.7	+0.1	18 20 56	−14 20	4	C	3.0	0.6	
17.0	−0.0	18 21 57	−14 08	5	S	0.5	0.5	
17.4	−2.3	18 30 55	−14 52	24?	S	5	0.5?	
17.4	−0.1	18 23 08	−13 46	6	S	0.4	0.7	
17.8	−2.6	18 32 50	−14 39	24	S	5	0.5	
18.1	−0.1	18 24 34	−13 11	8	S	4.6	0.5	
18.6	−0.2	18 25 55	−12 50	6	S	1.4	0.4	
18.8	+0.3	18 23 58	−12 23	17×11	S	33	0.46	Kes 67
18.9	−1.1	18 29 50	−12 58	33	C?	37	0.39	
19.1	+0.2	18 24 56	−12 07	27	S	10	0.5	
20.0	−0.2	18 28 07	−11 35	10	F	10	0.1	
21.0	−0.4	18 31 12	−10 47	9×7	S	1.1	0.6	
21.5	−0.9	18 33 33	−10 35	5	C	7	varies	
21.6	−0.8	18 33 40	−10 25	13	S	1.4	0.5?	
21.8	−0.6	18 32 45	−10 08	20	S	65	0.56	Kes 69
22.7	−0.2	18 33 15	−09 13	26	S?	33	0.6	
23.3	−0.3	18 34 45	−08 48	27	S	70	0.5	W41
24.7	−0.6	18 38 43	−07 32	15?	S?	8	0.5	
24.7	+0.6	18 34 10	−07 05	30×15	C?	20?	0.2?	
25.1	−2.3	18 45 10	−08 00	80×30?	S	8	0.5?	
27.4	+0.0	18 41 19	−04 56	4	S	6	0.68	4C−04.71
27.8	+0.6	18 39 50	−04 24	50×30	F	30	varies	
28.6	−0.1	18 43 55	−03 53	13×9	S	3?	?	
28.8	+1.5	18 39 00	−02 55	100?	S?	?	0.4?	
29.6	+0.1	18 44 52	−02 57	5	S	1.5?	0.5?	
29.7	−0.3	18 46 25	−02 59	3	C	10	0.63	Kes 75
30.7	−2.0	18 54 25	−02 54	16	?	0.5?	0.7?	
30.7	+1.0	18 44 00	−01 32	24×18	S?	6	0.4	
31.5	−0.6	18 51 10	−01 31	18?	S?	2?	?	
31.9	+0.0	18 49 25	−00 55	7×5	S	25	varies	3C391
32.0	−4.9	19 06 00	−03 00	60?	S?	22?	0.5?	3C396.1
32.1	−0.9	18 53 10	−01 08	40?	C?	?	?	
32.4	+0.1	18 50 05	−00 25	6	S	0.25?	?	
32.8	−0.1	18 51 25	−00 08	22×15	S?	11?	0.2?	Kes 78
33.2	−0.6	18 53 50	−00 02	18	S	3.5	varies	
33.6	+0.1	18 52 48	+00 41	10	S	20	0.51	Kes 79, 4C00.70, HC13
34.7	−0.4	18 56 00	+01 22	35×27	C	240	0.37	W44, 3C392

Table 1. *Continued.*

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
35.6	−0.4	18 57 55	+02 13	15×11	S?	9	0.5	
36.6	−0.7	19 00 35	+02 56	25?	S?	1.0	0.7?	
36.6	+2.6	18 48 49	+04 26	17×13?	S	0.7?	0.5?	
38.7	−1.3	19 06 40	+04 28	32×19?	S	?	?	
39.2	−0.3	19 04 08	+05 28	8×6	C	18	0.34	3C396, HC24, NRAO 593
39.7	−2.0	19 12 20	+04 55	120×60	?	85?	0.7?	W50, SS433
40.5	−0.5	19 07 10	+06 31	22	S	11	0.4	
41.1	−0.3	19 07 34	+07 08	4.5×2.5	S	25	0.50	3C397
41.5	+0.4	19 05 50	+07 46	10	S?	1?	?	
42.0	−0.1	19 08 10	+08 00	8	S?	0.5?	?	
42.8	+0.6	19 07 20	+09 05	24	S	3?	0.5?	
43.3	−0.2	19 11 08	+09 06	4×3	S	38	0.46	W49B
43.9	+1.6	19 05 50	+10 30	60?	S?	9.0	0.5	
45.7	−0.4	19 16 25	+11 09	22	S	4.2?	0.4?	
46.8	−0.3	19 18 10	+12 09	15	S	17	0.54	(HC30)
49.2	−0.7	19 23 50	+14 06	30	S?	160?	0.3?	(W51)
53.4	+0.0	19 29 57	+18 10	10?	S	1.5	0.6?	
53.6	−2.2	19 38 50	+17 14	33×28	S	8	0.50	3C400.2, NRAO 611
54.1	+0.3	19 30 31	+18 52	12?	C?	0.5	0.1	
54.4	−0.3	19 33 20	+18 56	40	S	28	0.5	(HC40)
55.0	+0.3	19 32 00	+19 50	20×15?	S	0.5?	0.5?	
55.7	+3.4	19 21 20	+21 44	23	S	1?	0.3?	
57.2	+0.8	19 34 59	+21 57	12?	S?	1.8	0.35	(4C21.53)
59.5	+0.1	19 42 33	+23 35	15	S	3?	?	
63.7	+1.1	19 47 52	+27 45	8	F	1.8	0.24	
64.5	+0.9	19 50 25	+28 16	8	S?	0.15?	0.5	
65.1	+0.6	19 54 40	+28 35	90×50	S	5.5	0.61	
65.3	+5.7	19 33 00	+31 10	310×240	S?	42	0.6	
65.7	+1.2	19 52 10	+29 26	22	F	5.1	varies	DA 495
66.0	−0.0	19 57 50	+29 03	31×25?	S	?	?	
67.6	+0.9	19 57 45	+30 53	50×45?	S	?	?	
67.7	+1.8	19 54 32	+31 29	15×12	S	1.0	0.61	
67.8	+0.5	20 00 00	+30 51	7×5	?	?	?	
68.6	−1.2	20 08 40	+30 37	23	?	1.1	0.2	
69.0	+2.7	19 53 20	+32 55	80?	?	120?	varies	CTB 80
69.7	+1.0	20 02 40	+32 43	16×14	S	2.0	0.7	
70.0	−21.5	21 24 00	+19 23	330×240	S	?	?	
73.9	+0.9	20 14 15	+36 12	27	S?	9	0.23	
74.0	−8.5	20 51 00	+30 40	230×160	S	210	varies	Cygnus Loop
74.9	+1.2	20 16 02	+37 12	8×6	F	9	varies	CTB 87
76.9	+1.0	20 22 20	+38 43	9	C	2?	?	
78.2	+2.1	20 20 50	+40 26	60	S	320	0.51	DR4, γ Cygni SNR
82.2	+5.3	20 19 00	+45 30	95×65	S	120?	0.5?	W63
83.0	−0.3	20 46 55	+42 52	9×7	S	1	0.4	
84.2	−0.8	20 53 20	+43 27	20×16	S	11	0.5	

Table 1. *Continued.*

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
85.4	+0.7	20 50 40	+45 22	24?	S	?	0.2	
85.9	−0.6	20 58 40	+44 53	24	S	?	0.2	
89.0	+4.7	20 45 00	+50 35	120×90	S	220	0.38	HB21
93.3	+6.9	20 52 25	+55 21	27×20	C?	9	0.45	DA 530, 4C(T)55.38.1
93.7	−0.2	21 29 20	+50 50	80	S	65	0.65	CTB 104A, DA 551
94.0	+1.0	21 24 50	+51 53	30×25	S	13	0.45	3C434.1
96.0	+2.0	21 30 30	+53 59	26	S	0.35	0.6	
106.3	+2.7	22 27 30	+60 50	60×24	C?	6	0.6	
108.2	−0.6	22 53 40	+58 50	70×54	S	8	0.5	
109.1	−1.0	23 01 35	+58 53	28	S	20	0.45	CTB 109
111.7	−2.1	23 23 26	+58 48	5	S	2300	0.77	Cassiopeia A, 3C461
113.0	+0.2	23 26 50	+61 26	40×17?	?	4	0.5?	
114.3	+0.3	23 37 00	+61 55	90×55	S	5.5	0.5	
116.5	+1.1	23 53 40	+63 15	80×60	S	10	0.5	
116.9	+0.2	23 59 10	+62 26	34	S	8	0.57	CTB 1
119.5	+10.2	00 06 40	+72 45	90?	S	36	0.6	CTA 1
120.1	+1.4	00 25 18	+64 09	8	S	50	0.58	Tycho, 3C10, SN1572
126.2	+1.6	01 22 00	+64 15	70	S?	6	0.5	
127.1	+0.5	01 28 20	+63 10	45	S	12	0.45	R5
130.7	+3.1	02 05 41	+64 49	9×5	F	33	0.07	3C58, SN1181
132.7	+1.3	02 17 40	+62 45	80	S	45	0.6	HB3
150.3	+4.5	04 27 00	+55 28	180×150	S	?	?	
152.4	−2.1	04 07 50	+49 11	100×95	S	3.5?	0.7?	
156.2	+5.7	04 58 40	+51 50	110	S	5	0.5	
159.6	+7.3	05 20 00	+50 00	240×180?	S	?	?	
160.9	+2.6	05 01 00	+46 40	140×120	S	110	0.64	HB9
166.0	+4.3	05 26 30	+42 56	55×35	S	7	0.37	VRO 42.05.01
178.2	−4.2	05 25 05	+28 11	72×62	S	2	0.5	
179.0	+2.6	05 53 40	+31 05	70	S?	7	0.4	
180.0	−1.7	05 39 00	+27 50	180	S	65	varies	S147
181.1	+9.5	06 26 40	+32 30	74	S	?	0.45?	
182.4	+4.3	06 08 10	+29 00	50	S	0.5	0.4	
184.6	−5.8	05 34 31	+22 01	7×5	F	900	0.30	Crab Nebula, 3C144, SN1054
189.1	+3.0	06 17 00	+22 34	45	C	165	0.36	IC443, 3C157
190.9	−2.2	06 01 55	+18 24	70×60	S	1.3?	0.7?	
205.5	+0.5	06 39 00	+06 30	220	S	140	0.4	Monoceros Nebula
206.9	+2.3	06 48 40	+06 26	60×40	S?	6	0.5	PKS 0646+06
213.0	−0.6	06 50 50	−00 30	160×140?	S	21	0.4	
260.4	−3.4	08 22 10	−43 00	60×50	S	130	0.5	Puppis A, MSH 08−44
261.9	+5.5	09 04 20	−38 42	40×30	S	10?	0.4?	
263.9	−3.3	08 34 00	−45 50	255	C	1750	varies	Vela (XYZ)
266.2	−1.2	08 52 00	−46 20	120	S	50?	0.3?	RX J0852.0−4622
272.2	−3.2	09 06 50	−52 07	15?	S?	0.4	0.6	
279.0	+1.1	09 57 40	−53 15	95	S	30?	0.6?	
284.3	−1.8	10 18 15	−59 00	24?	S	11?	0.3?	MSH 10−53

Table 1. *Continued.*

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
286.5	−1.2	10 35 40	−59 42	26×6	S?	1.4?	?	
289.7	−0.3	11 01 15	−60 18	18×14	S	6.2	0.2?	
290.1	−0.8	11 03 05	−60 56	19×14	S	42	0.4	MSH 11−6*1*A
291.0	−0.1	11 11 54	−60 38	15×13	C	16	0.29	(MSH 11−6*2*)
292.0	+1.8	11 24 36	−59 16	12×8	C	15	0.4	MSH 11−5*4*
292.2	−0.5	11 19 20	−61 28	20×15	S	7	0.5	
293.8	+0.6	11 35 00	−60 54	20	C	5?	0.6?	
294.1	−0.0	11 36 10	−61 38	40	S	>2?	?	
296.1	−0.5	11 51 10	−62 34	37×25	S	8?	0.6?	
296.5	+10.0	12 09 40	−52 25	90×65	S	48	0.5	PKS 1209−51/52
296.7	−0.9	11 55 30	−63 08	15×8	S	3	0.5	
296.8	−0.3	11 58 30	−62 35	20×14	S	9	0.6	1156−62
298.5	−0.3	12 12 40	−62 52	5?	?	5?	0.4?	
298.6	−0.0	12 13 41	−62 37	12×9	S	5?	0.3	
299.2	−2.9	12 15 13	−65 30	18×11	S	0.5?	?	
299.6	−0.5	12 21 45	−63 09	13	S	1.0?	?	
301.4	−1.0	12 37 55	−63 49	37×23	S	2.1?	?	
302.3	+0.7	12 45 55	−62 08	17	S	5?	0.4?	
304.6	+0.1	13 05 59	−62 42	8	S	14	0.5	Kes 17
306.3	−0.9	13 21 50	−63 34	4	S?	0.16?	0.5?	
308.1	−0.7	13 37 37	−63 04	13	S	1.2?	?	
308.4	−1.4	13 41 30	−63 44	12×6?	S?	0.4?	?	
308.8	−0.1	13 42 30	−62 23	30×20?	C?	15?	0.4?	
309.2	−0.6	13 46 31	−62 54	15×12	S	7?	0.4?	
309.8	+0.0	13 50 30	−62 05	25×19	S	17	0.5	
310.6	−1.6	14 00 45	−63 26	2.5	C?	?	?	
310.6	−0.3	13 58 00	−62 09	8	S	5?	?	Kes 20B
310.8	−0.4	14 00 00	−62 17	12	S	6?	?	Kes 20A
311.5	−0.3	14 05 38	−61 58	5	S	3?	0.5	
312.4	−0.4	14 13 00	−61 44	38	S	45	0.36	
312.5	−3.0	14 21 00	−64 12	20×18	S	3.5?	?	
315.1	+2.7	14 24 30	−57 50	190×150	S	?	?	
315.4	−2.3	14 43 00	−62 30	42	S	49	0.6	RCW 86, MSH 14−6*3*
315.4	−0.3	14 35 55	−60 36	24×13	?	8	0.4	
315.9	−0.0	14 38 25	−60 11	25×14	S	0.8?	?	
316.3	−0.0	14 41 30	−60 00	29×14	S	20?	0.4	(MSH 14−5*7*)
317.3	−0.2	14 49 40	−59 46	11	S	4.7?	?	
318.2	+0.1	14 54 50	−59 04	40×35	S	>3.9?	?	
318.9	+0.4	14 58 30	−58 29	30×14	C	4?	0.2?	
320.4	−1.2	15 14 30	−59 08	35	C	60?	0.4	MSH 15−5*2*, RCW 89
320.6	−1.6	15 17 50	−59 16	60×30	S	?	?	
321.9	−1.1	15 23 45	−58 13	28	S	>3.4?	?	
321.9	−0.3	15 20 40	−57 34	31×23	S	13	0.3	
322.1	+0.0	15 20 49	−57 10	8×4.5?	S?	?	?	
322.5	−0.1	15 23 23	−57 06	15	C	1.5	0.4	

Table 1. *Continued.*

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
323.5	+0.1	15 28 42	−56 21	13	S	3?	0.4?	
323.7	−1.0	15 34 30	−57 12	51×38	S	?	?	
326.3	−1.8	15 53 00	−56 10	38	C	145	varies	MSH 15−5*6*
327.1	−1.1	15 54 25	−55 09	18	C	7?	?	
327.2	−0.1	15 50 55	−54 18	5	S	0.4	?	
327.4	+0.4	15 48 20	−53 49	21	S	30?	0.6	Kes 27
327.4	+1.0	15 46 48	−53 20	14	S	1.9?	?	
327.6	+14.6	15 02 50	−41 56	30	S	19	0.6	SN1006, PKS 1459−41
328.4	+0.2	15 55 30	−53 17	5	F	15	0.0	(MSH 15−5*7*)
329.7	+0.4	16 01 20	−52 18	40×33	S	>34?	?	
330.0	+15.0	15 10 00	−40 00	180?	S	350?	0.5?	Lupus Loop
330.2	+1.0	16 01 06	−51 34	11	S?	5?	0.3	
332.0	+0.2	16 13 17	−50 53	12	S	8?	0.5	
332.4	−0.4	16 17 33	−51 02	10	S	28	0.5	RCW 103
332.4	+0.1	16 15 20	−50 42	15	S	26	0.5	MSH 16−5*1*, Kes 32
332.5	−5.6	16 43 20	−54 30	35	S	2?	0.7?	
335.2	+0.1	16 27 45	−48 47	21	S	16	0.5	
336.7	+0.5	16 32 11	−47 19	14×10	S	6	0.5	
337.0	−0.1	16 35 57	−47 36	1.5	S	1.5	0.6?	(CTB 33)
337.2	−0.7	16 39 28	−47 51	6	S	1.5	0.4	
337.2	+0.1	16 35 55	−47 20	3×2	?	1.5?	?	
337.3	+1.0	16 32 39	−46 36	15×12	S	16	0.55	Kes 40
337.8	−0.1	16 39 01	−46 59	9×6	S	15	0.5	Kes 41
338.1	+0.4	16 37 59	−46 24	15?	S	4?	0.4	
338.3	−0.0	16 41 00	−46 34	8	C?	7?	?	
338.5	+0.1	16 41 09	−46 19	9	?	12?	?	
340.4	+0.4	16 46 31	−44 39	10×7	S	5	0.4	
340.6	+0.3	16 47 41	−44 34	6	S	5?	0.4?	
341.2	+0.9	16 47 35	−43 47	22×16	C	1.5?	0.6?	
341.9	−0.3	16 55 01	−44 01	7	S	2.5	0.5	
342.0	−0.2	16 54 50	−43 53	12×9	S	3.5?	0.4?	
342.1	+0.9	16 50 43	−43 04	10×9	S	0.5?	?	
343.0	−6.0	17 25 00	−46 30	250	S	?	?	RCW 114
343.1	−2.3	17 08 00	−44 16	32?	C?	8?	0.5?	
343.1	−0.7	17 00 25	−43 14	27×21	S	7.8	0.55	
344.7	−0.1	17 03 51	−41 42	8	C?	2.5?	0.3?	
345.7	−0.2	17 07 20	−40 53	6	S	0.6?	?	
346.6	−0.2	17 10 19	−40 11	8	S	8?	0.5?	
347.3	−0.5	17 13 50	−39 45	65×55	S?	30?	?	RX J1713.7−3946
348.5	−0.0	17 15 26	−38 28	10?	S?	10?	0.4?	
348.5	+0.1	17 14 06	−38 32	15	S	72	0.3	CTB 37A
348.7	+0.3	17 13 55	−38 11	17?	S	26	0.3	CTB 37B
349.2	−0.1	17 17 15	−38 04	9×6	S	1.4?	?	
349.7	+0.2	17 17 59	−37 26	2.5×2	S	20	0.5	
350.0	−2.0	17 27 50	−38 32	45	S	26	0.4	

Table 1. *Continued.*

l /°	b /°	RA (J2000) /(h m s)	Dec /(° ′)	Size /arcmin	Type	Flux at 1 GHz/Jy	Spectral index	Other name(s)
350.1	−0.3	17 21 05	−37 27	4?	?	6?	0.8?	
351.0	−5.4	17 46 00	−39 25	30	S	?	?	
351.2	+0.1	17 22 27	−36 11	7	C?	5?	0.4	
351.7	+0.8	17 21 00	−35 27	18×14	S	10	0.5?	
351.9	−0.9	17 28 52	−36 16	12×9	S	1.8?	?	
352.7	−0.1	17 27 40	−35 07	8×6	S	4	0.6	
353.6	−0.7	17 32 00	−34 44	30	S	2.5?	?	
353.9	−2.0	17 38 55	−35 11	13	S	1?	0.5?	
354.1	+0.1	17 30 28	−33 46	15×3?	C?	?	varies	
354.8	−0.8	17 36 00	−33 42	19	S	2.8?	?	
355.4	+0.7	17 31 20	−32 26	25	S	5?	?	
355.6	−0.0	17 35 16	−32 38	8×6	S	3?	?	
355.9	−2.5	17 45 53	−33 43	13	S	8	0.5	
356.2	+4.5	17 19 00	−29 40	25	S	4	0.7	
356.3	−1.5	17 42 35	−32 52	20×15	S	3?	?	
356.3	−0.3	17 37 56	−32 16	11×7	S	3?	?	
357.7	−0.1	17 40 29	−30 58	8×3?	?	37	0.4	MSH 17−39
357.7	+0.3	17 38 35	−30 44	24	S	10	0.4?	
358.0	+3.8	17 26 00	−28 36	38	S	1.5?	?	
358.1	+1.0	17 37 00	−29 59	20	S	2?	?	
358.5	−0.9	17 46 10	−30 40	17	S	4?	?	
359.0	−0.9	17 46 50	−30 16	23	S	23	0.5	
359.1	−0.5	17 45 30	−29 57	24	S	14	0.4?	
359.1	+0.9	17 39 36	−29 11	12×11	S	2?	?	

are available, and should themselves include references to earlier work. These references are from the published literature up to the end of 2018.

The detailed version of the catalogue is available in pdf format for downloading and printing, or as web pages, including a page for each individual remnant. The web pages for each remnant include links to the 'NASA Astrophysics Data System' for each of the over three thousand references that are included in the detailed listings for individual SNRs.

Some of the parameters included in the catalogue are themselves of variable quality. For example, the radio flux density of each remnant at 1 GHz is generally obtained from several radio observations over a range of frequencies, both above and below 1 GHz, so it is of good quality. However, there are 21 remnants – often those which have been identified at other than radio wavelengths – for which no reliable radio flux density is available yet, because they have either not been detected or well observed in the radio. Although the detailed version of the catalogue contains notes on distances for many remnants reported in the literature, these are highly variable in terms of reliability and accuracy. Consequently, the distances given within the detailed catalogue should be used with caution in any statistical studies, and reference should be made to the primary literature cited in the detailed catalogue.

The detailed version of the catalogue also contains notes both on those objects no longer thought to be SNRs, and on the many possible and probable remnants that have been reported in the literature (including possible large, old remnants, seen from radio continuum, X-ray or H I observations). See Section 4.3 below for discussion of some recently proposed remnants.

It should be noted that the catalogue is far from homogeneous. Although many remnants, or possible remnants, were first identified from wide-area radio surveys, there are many others that have been observed with diverse observational parameters, making uniform criteria for inclusion in the main catalogue difficult. For an alternative, high-energy catalogue of SNRs, see Ferrand and Safi-Harb (2012).

3. SNRs added to, objects removed from the catalogue

Since the last published version (Green 2014), the following supernova remnants have been added to the catalogue.

- G351.0−5.4, which was identified by de Gasperin *et al.* (2014) from radio and other observations.
- A very high-latitude remnant, G70.0−21.5, identified primarily from optical observations by Fesen *et al.* (2015). Previously, Boumis *et al.* (2002) had noted optical filaments in this region, which they suggested were indicative of one or more SNRs. As noted by both Boumis *et al.* (2002) and Fesen *et al.* (2015), there is also faint X-ray emission from this remnant.
- G181.1+9.5, another high-latitude remnant, identified from radio observations by Kothes *et al.* (2017).
- G323.7−1.0, which was one of the several candidate remnant given by Green *et al.* (2014), was confirmed as a SNR from γ-ray observations, see Araya (2017) and H.E.S.S Collaboration *et al.* (2018).
- The possible faint radio SNRs near $l = 150^\circ\!.5$, $b = 4^\circ\!.0$ have been reported by Gerbrandt *et al.* (2014) and Gao & Han (2014). Gao & Han (2014) proposed a large (180×150 arcmin^2) remnant, G150.3+4.5, whereas Gerbrandt *et al.* (2014) proposed part of this as a smaller (61×18 arcmin^2) remnant, G150.8+3.8. Recently Ackermann *et al.* (2018) showed the extended γ-ray emission from much of G150.3+4.5, confirming it as a SNR.
- G53.4+0.0 was confirmed as a SNR by Driessen *et al.* (2018), from radio and X-ray observations. This is one of the several candidate SNRs in this region (e.g. Anderson *et al.* 2017). See also Dokara *et al.* (2018).

In this version of the catalogue, five objects previously listed as SNRs have been removed, namely (G20.4+0.1, G21.5−0.1, G23.6+0.3, G59.8+1.2 and G65.8−0.5), as they have been identified as H II regions by Anderson *et al.* (2017). Also, G192.8−1.1 has been removed, as Gao *et al.* (2011) showed that this is not a SNR (see also, Kang *et al.* 2014). Erroneously it was not removed from the 2014 version of the catalogue. Note that G358.1+1.0 was erroneously labelled G358.1+0.1 in the 2009 and 2014 versions of the catalogue, which has now been corrected.

4. Discussion

4.1 *Some simple statistics*

There are 21 Galactic SNRs which do not have a flux density at 1 GHz in the catalogue. This is because either the remnant has not been detected at radio wavelengths, or it is poorly defined by current radio observations, so that their flux density at 1 GHz cannot be determined with any confidence: i.e. 93% of the remnants do have a flux density at 1 GHz in the catalogue. Of the catalogued remnants, ≈42% are detected in X-rays, and ≈31% in the optical. The smaller proportion of SNR identified in the optical and X-ray wavebands is due to Galactic absorption, which hampers the detection of distant remnants.

In this version of the catalogue, 80% of remnants are classified as shell (or possible shell) remnants, 13% are composite (or possible composite) remnants, and just 3% are filled-centre (or possible filled centre) remnants. The types of the remaining remnants are not clear from current observations (or else they are objects which are conventionally regarded as SNRs although they do not fit well into any of the conventional types, e.g. CTB80 (=G69.0+2.7), MSH 17–39 (=G357.7−0.1).

4.2 *Selection effects*

In previous papers (e.g. Green 1991, 2005), the selection effects that apply to the identification of Galactic SNRs were discussed. Although some SNRs are identified first at other than radio wavelengths, most SNRs have been identified first in the radio. The selection effects for the SNR catalogue are therefore dominated by those that apply at radio wavelengths. These are: (i) the difficulty in finding low surface brightness remnants, and (ii) the difficulty in finding small angular size remnants.

In Green (2005), a surface brightness completeness limit of $\Sigma \approx 10^{-20}$ W m^{-2} Hz^{-1} sr^{-1} at 1 GHz was derived. This nominal completeness limit is supported by various searches for SNRs, as no remnants with a surface brightness above this limit have been added to the published versions of the catalogue since Green (2009). Xu *et al.* (2013) used multi-frequency radio observations to separate thermal and non-thermal radio emissions in a large region around Cygnus X ($66^\circ \le l \le 90^\circ$, $|b| < 4^\circ$). They did not find any new large SNRs with $\Sigma > 0.37 \times 10^{-20}$ W m^{-2} Hz^{-1} sr^{-1}, consistent with the previously quoted completeness limit. More recently, Anderson *et al.* (2017) have identified many candidate SNRs in the region $17.^\circ5 < l < 67.^\circ4$, $|b| \leq 1.^\circ25$, from THOR (Beuther *et al.* 2016) and VGPS (Stil *et al.* 2006) radio continuum observations at 1.4 GHz and mid-IR surveys. This covers a large fraction of the inner Galaxy – where most Galactic SNRs are expected to be – but only 2 of these candidates appear to have a surface brightness at 1 GHz above 10^{-20} W m^{-2} Hz^{-1} sr^{-1} (assuming a spectral index of 0.5 to scale the observed 1.4 GHz flux density to 1 GHz).

This surface brightness completeness limit of 10^{-20} W m^{-2} Hz^{-1} sr^{-1} was used in Green (2015) to select a sample of 69 SNRs from the 2014 version of the catalogue. This sample was then used to derive constraints on the distribution of remnants with Galactocentric radius. Of the six new remnants added to the catalogue since the 2014 version, only one (G53.4+0.0) has an integrated flux density at 1 GHz, and it is fainter than $\Sigma \approx 10^{-20}$ W m^{-2} Hz^{-1} sr^{-1}. The other five are either not detected in the radio (G70.0−21.5) or do not currently have integrated radio flux densities as they are faint. Of the objects removed from the catalogue since 2014, two had a surface brightness of 1.2×10^{-20} and 2.1×10^{-20} W m^{-2} Hz^{-1} sr^{-1} (for G20.4+0.1 and G23.6+0.3 respectively). So, the current catalogue contains 67 remnants with a surface brightness above 10^{-20} W m^{-2} Hz^{-1} sr^{-1}. This is two less than in the sample used in Green (2015), so that the results derived there will not be significantly changed.

Small angular size remnants – which will be the young but distant SNRs in the Galaxy – need to be resolved, for their structure to be recognized. Most wide-field radio surveys have not had small enough resolutions to easily identify such small angular size remnants. There are only 9 SNRs with angular diameters ≤ 3 arcmin in the catalogue, and none of these have been added to the catalogue since the 2009 version of the catalogue.

4.3 *Recently proposed SNRs*

As noted above, the detailed version of the catalogue includes notes on many objects that have been reported in the literature as possible or probable SNRs. Some of the recently proposed SNR candidates are discuseed here in more detail:

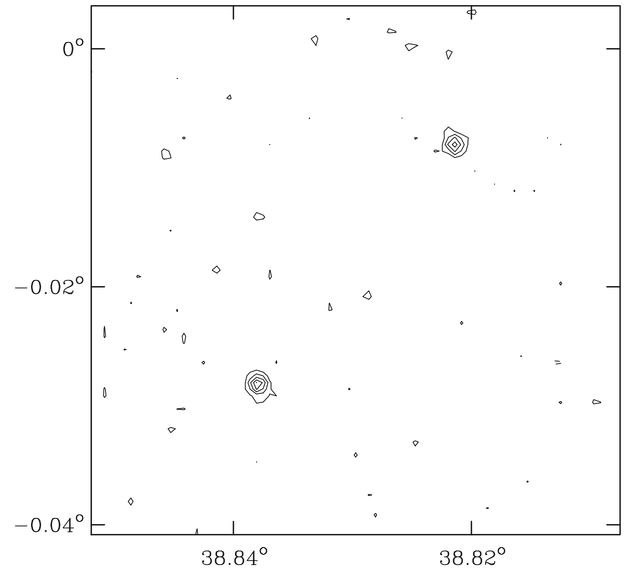

Figure 1. MAGPIS (Helfand *et al.* 2006) 1.4 GHz image, in Galactic coordinates, of the candidate SNR G38.83−0.01 reported in Anderson *et al.* (2017). Contour levels are ±0.8, 1.6, 2.4, 3.2, 4.0 mJy beam^{-1} (with the negative contours dashed). This image is observations made with the Very Large Array (VLA), in B, C and D configurations, with a resolution of approximately 6 arcsec.

- Demetroullas *et al.* (2015) suggested that a region of radio emission, which they label NGC 6334D, might be a SNR. This region, near $l = 351.^\circ6$, $b = 0.^\circ2$ was identified from their 31-GHz observations (with a resolution of ∼4.5 arcmin), apparently with a non-thermal radio spectrum. However, other available observations of this region do not support a SNR identification for NGC 6334D. Demetroullas *et al.* (2015) noted that there are two sources in the NRAO VLA Sky Survey (NVSS, Condon *et al.* 1998, at 1.4 GHz with a resolution of 45 arcsec) in the region of NGC 6334D, with peaks at 2.1 and 2.0 Jy beam^{-1}. Each of these sources have integrated flux densities of about 3.8 Jy in the NVSS catalogue, and other observations (e.g. Murphy *et al.* 2007) show they have relatively flat radio spectra. They are each associated with one or more compact H II regions identified by Giveon *et al.* (2005), from higher resolution 5-GHz and IR observations. The NVSS sources are separated by about 4 arcmin, and – with flat radio spectra – explain the emission of NGC 6334D seen in Demetroullas *et al.* (2015)'s lower resolution 31-GHz image. Higher quality 1.4-GHz observations from the SGPS (Haverkorn *et al.* 2006) do not show any obvious emission in this region – apart from that of the NVSS sources – that might indicate a SNR.
- A sample of 'giant radio sources' identified in the NVSS from pattern recognition techniques

is presented by Proctor (2016). One of these sources, NVGRC J205051.1+312728 – which is annotated with 'SNR?' as one of the several possibilities – is actually part of the Cygnus Loop (=G74.0−8.5, e.g. Green 1990). Several other of these sources also correspond to known SNRs, including other parts of the Cygnus Loop.
- As noted above, Anderson *et al.* (2017) identified many SNR candidates, which include several very small objects, 6 having a radius of $\leq$ 1 arcmin. If these were SNRs, then they would have to be physically small, even if in the distant Galaxy, and so would be scientifically interesting. Higher resolution radio images are available from the Multi-Array Galactic Plane Imaging Survey (MAGPIS, Helfand *et al.* 2006)[2] for several of these, but none of these look like young SNRs. In particular, G38.83−0.01 – which was reported as having a radius of 0.6 arcmin and a flux density at 1.4 GHz of 10 mJy – is clearly resolved into two-compact sources, see Figure 1, so is not a young SNR.
- Dzib *et al.* (2018) presented observations of a small (only about 15 arcsec in extent) radio shell, which they suggested may be a SNR. If this was a SNR, it would have to be very young, given its small angular size, even younger than the youngest known Galactic SNR G1.9+0.3 (e.g. Green *et al.* 2008; Reynolds *et al.* 2008). However, this source has already been identified as a candidate PN by Froebrich *et al.* (2015).

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References

Ackermann M. *et al.* 2018, ApJS, 237, 32
Anderson L. D. *et al.* 2017, A&A, 605, A58
Araya M. 2017, ApJ, 843, 12
Beuther H. *et al.* 2016, A&A, 595, A32
Boumis P., Mavromatakis F., Paleologou E. V., Becker W. 2002, A&A, 396, 225
Condon J. J., Cotton W. D., Greisen E. W., Yin Q. F., Perley R. A., Taylor G. B., Broderick J. J. 1998, AJ, 115, 1693
de Gasperin F., Evoli C., Brüggen M., Hektor A., Cardillo M., Thorman P., Dawson W. A., Morrison C. B. 2014, A&A, 568, A107
Demetroullas C. *et al.* 2015, MNRAS, 453, 2082
Dokara R. *et al.* 2018, ApJ, 866, 61
Driessen L. N., Domček V., Vink J., Hessels J. W. T., Arias M., Gelfand J. D. 2018, ApJ, 860, 133
Dzib S. A., Rodríguez L. F., Karuppusamy R., Loinard L., Medina S.-N. X. 2018, ApJ, 866, 100
Ferrand G., Safi-Harb S. 2012, AdSpR, 49, 1313
Fesen R. A., Neustadt J. M. M., Black C. S., Koeppel A. H. D. 2015, ApJ, 812, 37
Froebrich D. *et al.* 2015, MNRAS, 454, 2586
Gao X. Y., Han J. L. 2014, A&A, 567, A59
Gao X. Y., Han J. L., Reich W., Reich P., Sun X. H., Xiao L. 2011, A&A, 529, A159
Gerbrandt S., Foster T. J., Kothes R., Geisbüsch J., Tung A. 2014, A&A, 566, A76
Giveon U., Becker R. H., Helfand D. J., White R. L. 2005, AJ, 129, 348
Green D. A. 1984, MNRAS, 209, 449
Green D. A. 1988, Ap&SS, 148, 3
Green D. A. 1990, AJ, 100, 192
Green D. A. 1991, PASP, 103, 209
Green D. A. 2004, BASI, 32, 335
Green D. A. 2005, MmSAI, 76, 534
Green D. A. 2009, BASI, 37, 45
Green D. A. 2014, BASI, 42, 47
Green D. A. 2015, MNRAS, 454, 1517
Green D. A., Reynolds S. P., Borkowski K. J., Hwang U., Harrus I., Petre R. 2008, MNRAS, 387, L54
Green A. J., Reeves S. N., Murphy T. 2014, PASA, 31, e042
Haverkorn M., Gaensler B. M., McClure-Griffiths N. M., Dickey J. M., Green A. J. 2006, ApJS, 167, 230
HESS Collaboration: Abdalla H. *et al.* 2018, A&A, 612, A8
Helfand D. J., Becker R. H., White R. L., Fallon A., Tuttle S. 2006, AJ, 131, 2525
Kang J.-H., Koo B.-C., Byun D.-Y. 2014, JKAS, 47, 259
Kothes R., Reich P., Foster T. J., Reich W. 2017, A&A, 597, A116
Murphy T., Mauch T., Green A., Hunstead R. W., Piestrzynska B., Kels A. P., Sztajer P. 2007, MNRAS, 382, 382
Perley R. A., Butler B. J. 2017, ApJS, 230, 7
Proctor D. D. 2016, ApJS, 224, 18
Reynolds S. P., Borkowski K. J., Green D. A., Hwang U., Harrus I., Petre R. 2008, ApJ, 680, L41
Rho J., Petre R. 1998, ApJ, 503, L167
Stephenson F. R., Green D. A. 2002, Historical supernovae and their remnants, Oxford University Press
Stil J. M. *et al.* 2006, AJ, 132, 1158
Xu W. F., Gao X. Y., Han J. L., Liu F. S. 2013, A&A, 559, A81

[2]See also: https://third.ucllnl.org/gps/.