

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/138639> holds various files of this Leiden University dissertation.

Author: Mandal, S.

Title: Revealing the nature of new low-frequency radio source populations

Issue Date: 2020-12-10

Revealing the nature of new low-frequency radio source populations

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op donderdag 10 december 2020
klokke 11:15 uur

door

Soumyajit Mandal
geboren te Purulia, India
in 1992

Promotiecommissie

Promotor: Prof. dr. H. J. A. Röttgering
Co-promotor: Dr. R. J. van Weeren

Overige leden: Dr. I. Prandoni (IRA-INAF, Bologna)
Prof. dr. M. Brüggen (University of Hamburg)
Dr. H. T. Intema
Prof. dr. H. Hoekstra
Prof. dr. P. P. van der Werf

ISBN: 978-94-6423-083-3

Cover: The cover design and coloring is done by Elena Garuccio and Soumyajit Mandal. The background source of the front cover is the ‘radio phoenix’ in the galaxy cluster Abell 2593, as seen by LOFAR telescope and is overlaid with a ‘phoenix’, a mythological bird that is created from the ashes of its own predecessor. The back cover is a small section the Lockman Hole field. This is one of the deepest radio images ever made at 150 MHz.

*The sky is full of the sun and the stars
The universe is full of life
Among all these I have found a place
And in wonder and amazement I sing”*
—Rabindranath Tagore

Contents

1	Introduction	1
2	Merging galaxy cluster Abell 1914	13
2.1	Introduction	14
2.1.1	LOFAR data reduction	21
2.1.2	GMRT data reduction	24
2.1.3	VLA data reduction	26
2.1.4	Chandra data reduction	26
2.1.5	CFHT data	26
2.1.6	Spectral index maps and integrated spectrum calculation	27
2.2	Results	30
2.2.1	RP: A radio phoenix candidate	30
2.2.2	HT: A head-tail galaxy	31
2.2.3	RH: A radio halo candidate	31
2.3	Discussion	34
2.4	Summary and conclusions	37
3	Revived fossil plasma sources in galaxy clusters	41
3.1	Introduction	42
3.2	Sample selection	48
3.3	Observations and methods	49
3.3.1	GMRT data reduction	49
3.3.2	LOFAR data reduction	50

3.3.3	Spectral index maps and integrated spectrum calculation	50
3.3.4	X-ray data reduction	51
3.4	Results	52
3.4.1	Abell 2593	52
3.4.2	SDSS-C4-DR3-3088	54
3.4.3	Abell 2048	55
3.5	Discussion	60
3.5.1	AGN connection	60
3.5.2	Spectral index	60
3.5.3	Mass, temperature, dynamical state, and position of the radio source in the cluster	61
3.6	Conclusion	62
3.A	Spectral index error map	64
3.B	Additional spectral index and error maps of SDSS-C4-DR3-3088	65
4	Sample of radio phoenixes in galaxy clusters	67
4.1	Introduction	68
4.2	Sample Selection	76
4.3	Observations and Methods	77
4.3.1	GMRT Data Reduction	77
4.3.2	LOFAR Data Reduction	77
4.3.3	VLA Data Reduction	78
4.3.4	X-ray Data Reduction	78
4.3.5	Integrated spectral index	82
4.4	Results	82
4.5	Common properties	89
4.6	Discussion	92
4.7	Summary and conclusion	97
4.A	GMRT Maps	106
5	Source counts from LoTSS Deep Fields	109
5.1	Introduction	110
5.2	Observations and Data reduction	116
5.3	Source extraction, masking and deblending	117
5.3.1	Visibility function of raw and final catalogues	118
5.3.2	Source Size Deconvolution	119
5.4	Source Size Distribution and Resolution Bias	124
5.5	Eddington bias	134
5.6	Differential source counts	139

5.7 Conclusions	143
5.8 Acknowledgements	144
5.A Appendix	146
Bibliography	146
Nederlandse samenvattig	167
List of publications	173
Curriculum Vitae	177
Acknowledgements	179

