

Table of contents

PART I: Low-Energy Electron Scattering on ^{12}C and the Structure of the Hoyle State	1
1 Introduction	1
2 Theoretical background	7
2.1 Electron scattering	7
2.1.1 Monopole transitions	8
2.2 Model approaches	11
2.2.1 Fermionic molecular dynamics model	11
2.2.2 α -Cluster model	12
2.2.3 Bose-Einstein condensate model	13
3 Experiment at the S-DALINAC	14
3.1 S-DALINAC	14
3.2 Lintott Spectrometer	15
3.3 Details of the experiment	18
4 Data analysis	21
4.1 Decomposition of the spectra	21
4.2 Energy calibration	22
4.3 Determination of the cross section	23
4.4 Error estimation	24
5 Results and discussions	26
5.1 Form factor results	26
5.2 Extraction of monopole matrix element	27

5.2.1	PWBA analysis	27
5.2.2	Fourier-Bessel analysis	28
5.2.3	Pair width of the Hoyle state	31
5.3	Comparison with model results	32
5.3.1	Monopole matrix element	32
5.3.2	Form factors	37
6	Role of the 96 keV level in the $^{19}\text{O}(\beta^-)^{19}\text{F}$ process at stellar temperatures	41
6.1	Modelling of the β decay	41
6.2	Shell model description	45
6.3	Results and discussion	47
7	Summary and outlook	50
PART II: Construction of a Neutron Ball for Exclusive Electron Scattering Experiments at the S-DALINAC		52
8	Introduction	52
9	QCLAM spectrometer	55
10	Design and technical realization of the neutron ball	58
10.1	Scattering chamber	58
10.2	Detector support	58
11	Measurement of detector properties	63
11.1	Readout electronics	63
11.2	n/ γ -Discrimination	65

11.3 Pulse-height calibration	67
11.4 Fission chamber	72
12 Summary and outlook	76
A Drawing of the scattering chamber	77