

# Table of contents

<b>List of figures</b>	<b>xix</b>
<b>List of tables</b>	<b>xxviii</b>
<b>Nomenclature</b>	<b>xxviii</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Solar Magnetism and Cycle . . . . .	3
1.2 Proxies of Solar Magnetism . . . . .	10
1.3 Prediction of Solar Activity and its Necessity . . . . .	12
1.4 Origin of Solar Magnetism . . . . .	14
1.4.1 Basics of Magnetohydrodynamics . . . . .	15
1.4.2 Magnetoconvection . . . . .	17
1.4.3 Essentials of Solar Dynamo . . . . .	18
1.4.4 Babcock–Leighton Dynamo Model for Solar Cycle . . . . .	31
<b>2 Variability in Sun’s magnetic field due to irregular properties of BMRs</b>	<b>35</b>
2.1 Introduction . . . . .	36
2.2 Model . . . . .	39
2.2.1 STABLE model . . . . .	41
2.2.2 Deposition of synthetic BMRs in STABLE . . . . .	43

2.3	Results and Discussion . . . . .	44
2.3.1	Variation in the polar field . . . . .	44
2.3.2	Variation in the solar cycle . . . . .	50
2.4	Conclusions . . . . .	54
<b>3</b>	<b>Solar cycle prediction using polar precursor method with different predictors</b>	<b>55</b>
3.1	Introduction . . . . .	56
3.2	Observational data analysis . . . . .	59
3.2.1	Data . . . . .	59
3.2.2	Solar cycle landmarks . . . . .	60
3.2.3	Correlations in the observed data . . . . .	62
3.3	The polar precursor in solar dynamo models . . . . .	65
3.3.1	Surya dynamo model . . . . .	67
3.3.2	STABLE dynamo model . . . . .	70
3.3.3	$2 \times 2D$ dynamo model . . . . .	71
3.4	Conclusions . . . . .	74
<b>4</b>	<b>Physical Link of Polar Field Buildup With Waldmeier Effect and Solar Cycle Prediction</b>	<b>78</b>
4.1	Introduction . . . . .	79
4.2	Data and Methods . . . . .	81
4.3	Results and Discussion . . . . .	81
4.3.1	WE2 and the prediction of Cycle 25 . . . . .	81
4.3.2	Connecting WE2 with the previous cycle polar field . . . . .	84
4.3.3	Correlation with the rise rate of the polar field and the prediction of Cycle 25 . . . . .	86
4.4	Conclusions . . . . .	88

---

<b>5</b>	<b>Dynamo supercriticality and memory of the polar field</b>	<b>91</b>
5.1	Introduction . . . . .	92
5.2	Models . . . . .	94
5.2.1	Flux Transport Dynamos . . . . .	95
5.2.2	Time Delay Dynamo . . . . .	97
5.3	Results from Flux Transport Dynamo Models . . . . .	97
5.3.1	Identifying critical dynamo parameters . . . . .	99
5.3.2	Identifying the correlation of polar field . . . . .	100
5.4	Results from Time Delay Dynamo Model . . . . .	110
5.5	Comments on the conclusion of Yeates et al. (2008) . . . . .	111
5.6	Conclusions and Discussions . . . . .	112
<b>6</b>	<b>Conclusions and future outlook</b>	<b>115</b>
	<b>References</b>	<b>119</b>