Dynamical Structure and Evolution of Stellar Systems

Ven, Glenn van de

Dynamical Structure and Evolution of Stellar Systems

Dynamical Structure and Evolution of Stellar Systems

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van de Rector Magnificus Dr. D.D. Breimer,
hoogleraar in de faculteit der Wiskunde en
Natuurwetenschappen en die der Geneeskunde,
volgens besluit van het College voor Promoties
te verdedigen op donderdag 1 december 2005
klokke 15.15 uur

door

Petrus Martinus van de Ven

geboren te Mill en Sint Hubert
in 1977

Promotiecommissie

Promotor:	Prof. dr. P.T. de Zeeuw
Referent:	Prof. dr. K.C. Freeman (Australian National University)
Overige leden:	Prof. dr. P.G. van Dokkum (Yale University, USA) Prof. dr. M. Franx Prof. dr. H.J. Habing Dr. A. Helmi (Rijksuniversiteit Groningen) Prof. dr. C. Hunter (Florida State University, USA) Prof. dr. K. Kuijken

Omslag: Zonsondergang in Amboseli National Park, Kenia. Deze foto met op de achtergrond de Kilimanjaro is genomen tijdens mijn huwelijksreis in mei 2005.

TABLE OF CONTENTS

		Page
CHAPTER 1. INTRODUCTION		**1**
1	Stellar systems	1
2	Surface brightness	2
3	Two-dimensional kinematics	3
4	Dynamical models	4
5	Dynamical structure and evolution	6
6	This thesis	7
7	Future prospects	10
CHAPTER 2. THE DYNAMICAL DISTANCE AND STRUCTURE OF ω CENTAURI		**13**
1	Introduction	14
2	Observations	15
3	Selection	20
4	Kinematics	24
5	Schwarzschild's method	33
6	Tests	36
7	Dynamical models for ω Cen	41
8	Best-fit parameters	47
9	Intrinsic structure	50
10	Conclusions	60
A	Maximum likelihood estimation velocity moments	64
B	Polar grid of apertures	66
C	Simple distance estimate	68
CHAPTER 3. A BAR SIGNATURE AND CENTRAL DISK IN NGC 5448		**71**
1	Introduction	72
2	The data	73
3	Analyzing gas velocity fields	75
4	A bar model for NGC 5448	78
5	Results	80
6	Discussion and conclusions	85
CHAPTER 4. RECOVERY OF THREE-INTEGRAL GALAXY MODELS		**89**
1	Introduction	90
2	Triaxial Abel models	92
3	Observables	98
4	Triaxial three-integral galaxy models	102
5	Axisymmetric three-integral galaxy models	109
6	Recovery of triaxial galaxy models	112
7	Recovery of axisymmetric galaxy models	120
8	Discussion and conclusions	123
A	Limiting cases	127

B The function $\mathcal{M}(s,i,j;a,b,\phi)$ 130
C Conversion from true moments to Gauss-Hermite moments 132

CHAPTER 5. GENERAL SOLUTION OF THE JEANS EQUATIONS **137**
1 Introduction 138
2 The Jeans equations for separable models 139
3 The two-dimensional case 151
4 The general case 169
5 Discussion and conclusions 187
A Solving for the difference in stress 190

CHAPTER 6. THE EINSTEIN CROSS: LENSING VS. STELLAR DYNAMICS **195**
1 Introduction 196
2 Observations 197
3 Analysis 199
4 Results 206
5 Discussion 208
6 Conclusions 209

CHAPTER 7. FP AND M/L EVOLUTION OF LENS GALAXIES **213**
1 Introduction 214
2 FP parameters 215
3 Transformation to restframe 218
4 FP and M/L evolution 220
5 Stellar population ages 223
6 Colors 227
7 Summary and conclusions 229

LIST OF PUBLICATIONS **233**

NEDERLANDSE SAMENVATTING **235**

CURRICULUM VITAE **246**

NAWOORD **247**

APPENDIX: COLOR FIGURES **249**