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INTERNATIONAL CONFERENCE on

Artificial Intelligence for Computing, Astronomy and Renewable Energy

Organized by Centre of Excellence in Renewable Energy and Centre of Excellence in Astronomical Studies

AICARE 2025

21st and 22nd November ,2025

ABOUT AICARE

International Conference on "Artificial Intelligence for Computing, Astronomy and Renewable Energy" (AICARE 2025) is being organized by the Centre Of Excellence in Renewable Energy, UEM Kolkata and Centre Of Excellence in Astronomy, UEM KOLKATA. The conference is technically co-sponsored by IEEE Kolkata Section.Participants from academia, industry, and government agencies come together to present their research findings, discuss challenges and propose innovative solutions to address the evolving demands of the different Engineering fields. Through keynote speeches, technical sessions, and networking opportunities, the conference aims to stimulate interdisciplinary discussions and inspire new avenues of research that contribute to the advancement of modern Artificial Intelligence and IOT based engineering practices worldwide.

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SUBJECT TRACKS

AI IN ASTRONOMY

- Machine Learning for Astrophysical Data Analysis
- Deep Learning in Image Processing for Astronomy
- AI for Exoplanet Detection and Characterization
- Time Series Analysis of Astronomical Data
- AI in Telescope Automation and Control
- Big Data Challenges in Astronomy
- AI-Driven Simulations of Cosmic Phenomena
- Neural Networks for Galaxy Classification
- AI Applications in Radio Astronomy
- Machine Learning for Gravitational Wave Detection
- Predictive Modeling of Stellar Evolution
- Data Mining Techniques for Large Astronomical Surveys
- AI for Cosmological Simulations and Modeling
- Natural Language Processing in Astronomy Research
- AI in Space Mission Planning and Operations
- Anomaly Detection in Astronomical Observations
- AI for Multi-Messenger Astronomy
- Visualization Techniques for AI-Generated Astronomical Data
- AI Ethics and Fairness in Astronomy Research
- Future Trends: Quantum Computing and AI in Astronomy

AI APPLICATIONS IN UAV NETWORKS

- AI enabled UAV applications in Autonomous Navigation and Flight Control
- Computer Vision Techniques for Smart UAVs
- AI-Enhanced Object Detection and Tracking
- Swarm Intelligence and Cooperative UAV Systems
- Machine Learning for Environmental Monitoring
- AI enabled UAV Applications in Precision Agriculture
- Data Processing and Analysis for UAV Imagery
- Ethics and Regulations in UAV AI Applications
- UAVs in Search and Rescue Operations
- Security Challenges in UAV Operations and AI Solutions
- New opportunities/challenges/use cases for UAV-enabled IoT
- UAV swarming and coordination for IoT deployments
- UAV-assisted data collection and analytics for IoT applications
- Protocols and architectures for UAV-enabled MEC
- Computation offloading for UAV-enabled MEC
- UAV's trajectory design for UAV-enabled IoT
- Spectrum management and multiple access schemes for UAV-enabled IoT
- Green energy powered UAV-enabled IoT networks
- MIMO/massive MIMO/millimeter wave technologies for UAV-enabled IoT
- Quality of Service provisioning for UAV-enabled IoT
- Network security and information assurance for UAV-enabled IoT

APPLICATIONS OF AI IN COMPUTING

- Machine Learning and Deep Learning Innovations
- Natural Language Processing Applications
- AI in Cybersecurity
- Ethics and Fairness in AI
- AI for Fog Computing
- AI in Cloud Computing
- AI for Edge Computing
- Reinforcement Learning Techniques
- Computer Vision and Image Processing
- Explainable AI (XAI)
- AI for IIoT (Industrial Internet of Things)
- Data Privacy and AI
- AI-Driven Software Engineering
- AI in Robotics and Automation
- Augmented Reality and AI
- AI for Predictive Analytics
- AI in Healthcare Computing
- Quantum Computing and AI
- AI for Resource Optimization

AI IN RENEWABLE ENERGY

- Machine Learning for Renewable Energy Forecasting
- AI in Smart Grid Management and Optimization
- Predictive Maintenance for Renewable Energy Systems
- AI-Driven Energy Storage Solutions
- Data Analytics for Solar Energy Performance
- Wind Energy Prediction and Optimization using AI
- AI in Electric Vehicle Integration with Renewable Energy
- Decentralized Energy Management using Blockchain and AI
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- AI in Hydropower Generation and Management
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- Environmental Impact Assessment using AI Techniques
- Integration of AI in Climate Change Mitigation Strategies
- AI and IoT for Enhanced Energy Monitoring Systems
- Smart Renewable Energy System Design with AI
- Data-Driven Policy Making in Renewable Energy
- Future Trends: AI and Next-Generation Renewable Technologies
- Green energy technologies

KEY DATES

- 3rd March , 2025 : Full Paper Submission Begins
- 6th June , 2025 : Paper Submission Ends
- 4th August , 2025 : Acceptance Notifications
- 15th September , 2025 : Camera Ready Submissions
- 21st and 22nd November , 2025 : Conference Dates

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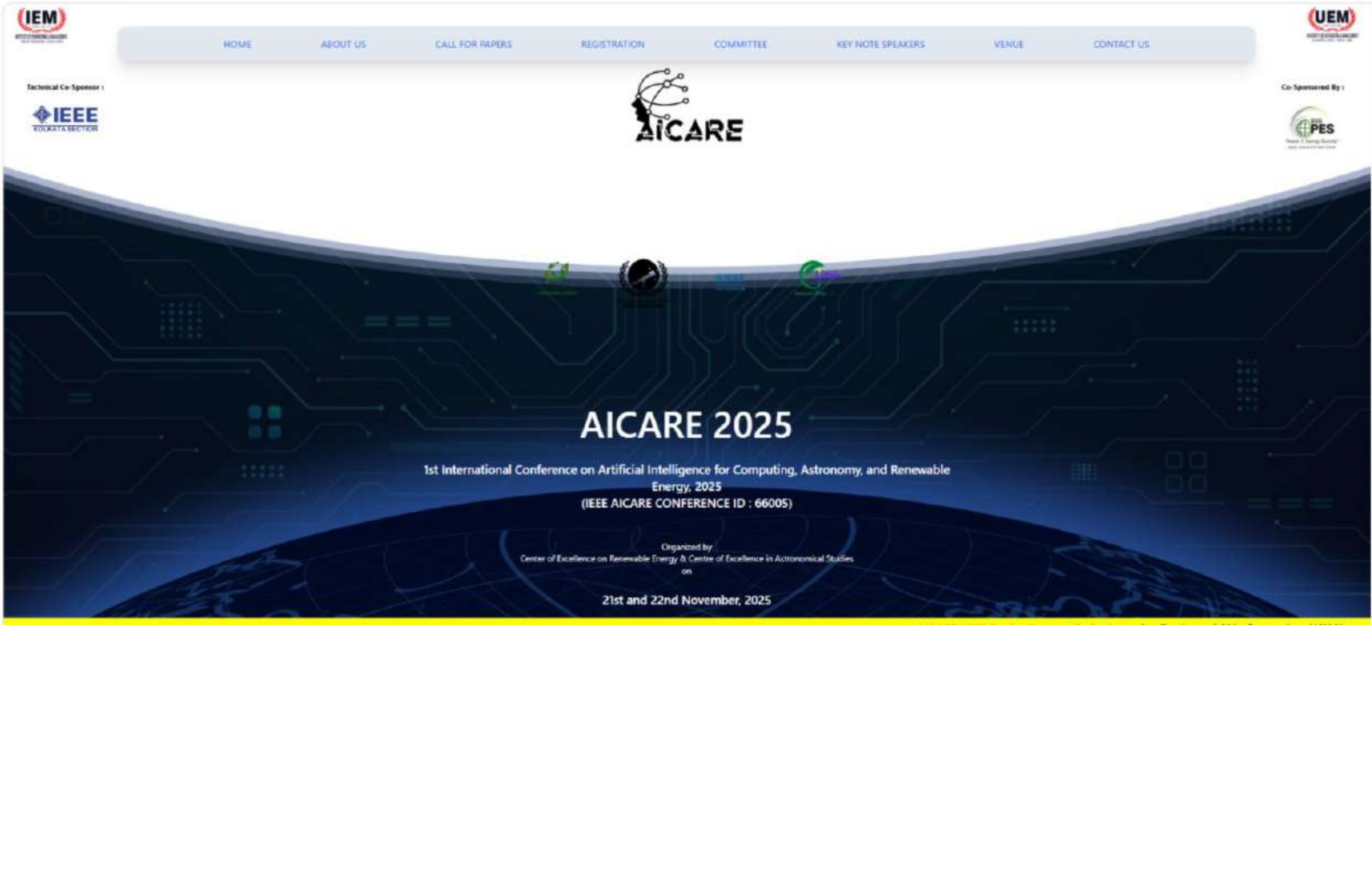
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Study of the Rotation Curve of a Low-Mass Disc Galaxy

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***Abstract*—In this work, we have performed a parametric fit of the rotation curve of a low-mass spiral disc galaxy, NGC2403. We have implemented the Marcov Chain Monte Carlo (MCMC) procedure to fit the observational data with our model. Then, we have summarized the properties of each of the parameters and their contributions to the rotation curve. Finally, we computed the mass of the galaxy.**

***Index Terms*—Marcov Chain Monte Carlo Simulation, Low-mass disc galaxy, Rotation curve**

I. Introduction

The study of galactic rotation curves has played a significant role in shaping our understanding of the dynamics of galaxies as well as the distribution of mass in the Universe. Since the pioneering work of Rubin [1], who demonstrated that the outer regions of spiral galaxies exhibit nearly flat rotation curves, it has become evident that luminous matter alone cannot account for the observed kinematics. This discrepancy between the dynamical and visible mass distributions has provided some of the strongest evidence for the existence of dark matter [2].

Rotation curves serve as an essential diagnostic tool for studying the contributions of different mass components in galaxies, including stars, gas, and the surrounding dark matter halo. Various theoretical models have been developed to characterize dark matter distributions. Cosmological simulations typically predict cuspy halo profiles, exemplified by the Navarro–Frenk–White (NFW) model [3], while observational studies of low-surface-brightness and dwarf galaxies often favor cored alternatives, such as the Burkert profile [4]. Distinguishing between these models is essential for constraining the nature of dark matter and testing alternative theories of gravity.

Despite their importance, fitting rotation curves remains challenging due to several factors. Observational uncertainties such as distance errors, inclination corrections, and limited spatial resolution can significantly affect the derived velocities. From a theoretical perspective, degeneracies often arise between baryonic and dark matter contributions, making it difficult to obtain unique mass decompositions [5]. In addition, robust statistical techniques are required to explore the parameter space and quantify uncertainties. Recent approaches have employed Bayesian inference and Markov Chain Monte Carlo (MCMC) methods to overcome these limitations [6]–[8].

Large galaxy samples with high-quality data, such as the Spitzer Photometry and Accurate Rotation Curves (SPARC) database [9], have enabled systematic studies of mass modeling across a wide range of galaxy types. These datasets provide an unprecedented opportunity to test theoretical predictions of dark matter halo structures and their scaling relations.

In this work, we perform detailed modeling of the rotation curve of a low-mass galaxy NGC 2403, making use of rotational velocity data from SPARC observations [9]. In order to constrain the parameters of our model, we have adopted a Bayesian inference framework. Traditional least-

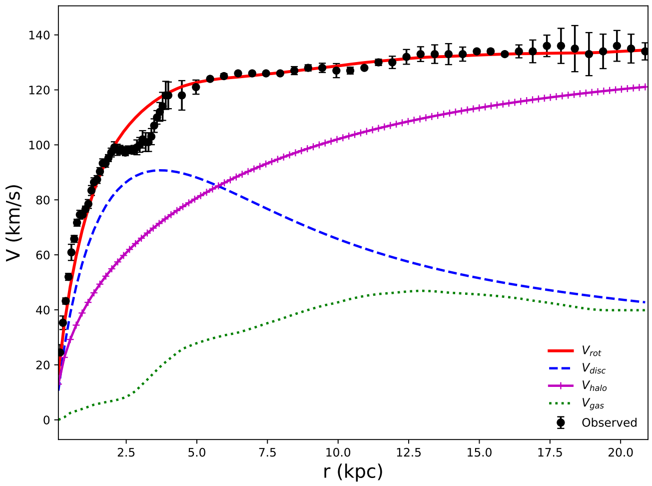

Fig. 7. Viable model predicted velocities: Total rotational velocity (Red solid line), halo velocity (magenta dashed line), disc velocity (blue line), gas velocity (green data points). The observed data points for total rotational velocity are plotted as black circular points.

$1.63 \times 10^{10}\ M_{\odot}$, which is consistent with the baryonic mass calculated by Verheijen & de Block [20] ($1.3 \times 10^{10}\ M_{\odot}$).

V. Summary and Conclusions

This study investigates the velocity distribution of the low-mass spiral galaxy NGC 2403 using observational data from the SPARC database. The total rotational velocity of the galaxy is modeled as the combined contribution of gas, stellar disc, and a dark matter halo, where the halo is described by the NFW profile.

To constrain the model parameters, a Bayesian inference framework was adopted, with posterior distributions sampled using the MCMC ensemble sampler implemented in `emcee`. Four principal free parameters were considered: the central surface density of the disc (Σ_0), the radius of the scale of the disc (h_r), the characteristic halo mass (M_0), and the halo scale length (a). The contribution of each parameter in shaping the rotation curve was systematically explored, revealing how variations in baryonic and dark-matter distributions influence the kinematics of the galaxy. The posterior distributions show good convergence, and the values of the best-fitting parameters successfully reproduce the observed flat rotation curve. The decomposition of the model highlights that the stellar disc dominates the inner regions of the galaxy, while the dark matter halo dominates the dynamics at larger radii. We have got the following conclusions from the present work.

- The stellar disc sets the amplitude of the rotation curve in the central region ($r < 5$ kpc), whereas the dark-matter halo dominates beyond $r > 10$ kpc.
- The observed flatness of the outer rotation curve requires the presence of a significant and extensive dark matter halo.
- The four free parameters—Σ_0, h_r, M_0, and a—have distinct physical effects, controlling respectively the disc's mass concentration, radial extent, halo mass, and halo concentration.
- The excellent agreement between the modeled and observed velocities and mass confirms that a disc + gas + NFW halo model provides a reliable description of the dynamical structure of NGC 2403.

References

[1] V. C. Rubin, N. Thonnard, and W. K. Ford, Jr., "Rotational properties of 21 SC galaxies with a large range of luminosities and radii, from NGC 4605 /R = 4kpc/ to UGC 2885 /R = 122 kpc/," *The Astrophysical Journal*, vol. 238, p. 471, June 1980.

[2] A. Bosma, "21-cm line studies of spiral galaxies. II. The distribution and kinematics of neutral hydrogen in spiral galaxies of various morphological types.," *The Astronomical Journal*, vol. 86, p. 1825, Dec. 1981.

[3] J. F. Navarro, C. S. Frenk, and S. D. M. White, "The Structure of Cold Dark Matter Halos," *The Astrophysical Journal*, vol. 462, p. 563, May 1996.

[4] A. Burkert, "The Structure of Dark Matter Halos in Dwarf Galaxies," *The Astrophysical Journal*, vol. 447, p. L25, July 1995.

[5] W. J. G. De Blok and S. S. McGaugh, "The dark and visible matter content of low surface brightness disc galaxies," *Monthly Notices of the Royal Astronomical Society*, vol. 290, p. 533, Sept. 1997.

[6] S.-H. Oh, D. A. Hunter, E. Brinks, B. G. Elmegreen, A. Schruba, F. Walter, M. P. Rupen, L. M. Young, C. E. Simpson, M. C. Johnson, K. A. Herrmann, D. Ficut-Vicas, P. Cigan, V. Heesen, T. Ashley, and H.-X. Zhang, "High-resolution mass models of dwarf galaxies from little THINGS," *The Astronomical Journal*, vol. 149, p. 180, May 2015.

[7] P. Li, F. Lelli, S. McGaugh, and J. Schombert, "A comprehensivecatalog of dark matter halo models for SPARC galaxies," *The Astrophysical Journal Supplement Series*, vol. 247, p. 31, Mar. 2020.

[8] A. Granados, D. Torres, L. Castañeda, L. Henao, and S. Vanegas, "GalRotpy: a tool to parametrize the gravitational potential of disc-like galaxies," *New Astronomy*, vol. 82, p. 101456, Jan. 2021.

[9] F. Lelli, S. S. McGaugh, and J. M. Schombert, "SPARC: Mass models for 175 disk galaxies with SPITZER photometry and accurate rotation curves," *The Astronomical Journal*, vol. 152, p. 157, Dec. 2016.

[10] F. Walter, E. Brinks, W. De Blok, F. Bigiel, R. C. Kennicutt Jr, M. D. Thornley, and A. Leroy, "THINGS: The HI nearby galaxy survey," *The Astronomical Journal*, vol. 136, no. 6, p. 2563, 2008.

[11] I. D. Karachentsev, V. E. Karachentseva, W. K. Huchtmeier, and D. I. Makarov, "A catalog of neighboring galaxies," *The Astrophysical Journal*, vol. 127, p. 2031, Apr 2004.

[12] F. Fraternali, T. Oosterloo, R. Sancisi, and G. van Moorsel, "A new, kinematically anomalous HI component in the spiral galaxy NGC 2403," *The Astrophysical Journal*, vol. 562, p. L47, Nov 2001.

[13] W. J. G. de Blok, F. Walter, E. Brinks, C. Trachternach, S.-H. Oh, and R. C. Kennicutt, "High-resolution rotation curves and galaxy mass models from things," *The Astronomical Journal*, vol. 136, p. 2648, Nov 2008.

[14] S. Sau, T. Chattopadhyay, and P. Ray, "Star formation histories of dwarf and giant galaxies with different supernovae-driven outflows: NGC 2403, NGC 628," *New Astronomy*, vol. 100, p. 101992, 2023.

[15] M. Yukita, D. A. Swartz, R. Soria, and A. F. Tennant, "Discovery of a transient x-ray source in the compact stellar nucleus of NGC 2403," *The Astrophysical Journal*, vol. 664, no. 1, p. 277, 2007.

[16] J. Binney and S. Tremaine, *Galactic dynamics*. Princeton series in astrophysics, Princeton: Princeton University Press, 2nd ed., 2008.

[17] K. C. Freeman, "On the Disks of Spiral and so Galaxies," *The Astrophysical Journal*, vol. 160, p. 811, June 1970.

[18] D. Foreman-Mackey, D. W. Hogg, D. Lang, and J. Goodman, "emcee: The mcmc hammer," *Publications of the Astronomical Society of the Pacific*, vol. 125, p. 306, Feb 2013.

[19] F. Fraternali, G. van Moorsel, R. Sancisi, and T. Oosterloo, "Deep HI survey of the spiral galaxy NGC 2403," *The Astrophysical Journal*, vol. 123, p. 3124, Jun 2002.

[20] M. Verheijen and E. De Blok, "The HSB/LSB Galaxies NGC 2403 and UGC 128," *Astrophysics and Space Science*, vol. 269-270, p. 673, Dec. 1999.