IAU Symposium

270

31 May - 4 June 2010,
Barcelona, Catalonia, Spain

Proceedings of the International Astronomical Union

Computational Star Formation

Edited by

João Alves
Bruce G. Elmegreen
Josep M. Girart
Virginia Trimble

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COVER ILLUSTRATION: Star fomation simulation

This image shows the distribution of gas and stars in two galaxies ∼50 Myr after their encounter. Cold and hot gas are shown in brown and blue colors, respectively. Young, intermediate-age, and old stars are shown as white, yellow, and red colored points, respectively. A number of star clusters are formed between two galaxies. The formation process of these star clusters is "bottom-up", quite different from the conventional "monolithic" picture of star cluster formation.

Credit: Takayuki Saitoh (Division of Theoretical Astrophysics/National Astronomical Observatory of Japan) & Takaaki Takeda (4D2U project/National Astronomical Observatory of Japan)

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Table of Contents

Presentations

Session I. Historical Introduction

Session II. Individual Star Formation: Observations

Session III. Individual Star Formation: Theory

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Session IV. Formation of Clusters: Observations

Session V. Formation of Clusters: Theory I

Session VI. Formation of Clusters: Theory II

Session VII. Numerical Methods: MHD

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Session VIII. Numerical Methods: Radiative Dynamics

Session IX. Tuesday Evening: Local Star Formation Processes

Session X. Star Formation Feedback I

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Session XI. Star Formation Feedback II

Session XII. Star Formation Feedback III

Session XIII. Star Formation on Galactic Scales I

Session XIV. Star Formation on Galactic Scales II

Session XVIII. Large Scale Star Formation

Session XIX. Cosmological Star Formation

Session XX. Computational Star Formation

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Preface

IAU Symposium 270 had its origins at the Fall 2008 JENAM meeting in Vienna, where three of the four present editors participated in a session on star formation that proved too short to clarify either all of the problems or what progress was being made on them. We decided that a larger meeting would be useful, particularly one with an emphasis on numerical simulations and comparisons with observations. Fortunately, the IAU executive committee agreed.

Star formation is complex, involving unknown initial conditions and poorly understood physical processes, such as supersonic turbulence, magnetic diffusion and reconnection, radiation transfer of background and young stellar light, and cooling by collisional excitation and decay of transient molecules and dust particles, all operating in a medium with rapidly changing substructures spanning 20 orders of magnitude in density. It is a violent storm of collapse into filaments, clumps, disks, and protostars, with equally violent energy release in the form of jets, winds, and heat, plus ionization when the most massive stars appear. Yet viewed at various embedded stages through infrared, mm, and radio telescopes, the result of this activity is a fairly regular assortment of young stars and protostars, with a power law distribution of separations and a power law distribution of masses, both extending from the largest scales and masses down to minimum values where the motions become subsonic. By the time these stars are visible to the eye in the night sky, the process is mostly over, the dense gas has dispersed, the jets have calmed, and the dense young clusters have started to disperse.

What lies between the dispersed gas before star formation and the dispersed gas after star formation, minus the few percent that has turned into stars, is the concern of theoreticians and observers at this conference. After 50 years of exponential growth in the speed, storage, and capacity of computers, we are at a stage where many of the formerly unimaginable processes involved with star formation can be studied with some realism. These processes include cloud formation in galaxies, cloud turbulence and collapse, disk and binary star formation, pre-stellar jets and winds, the effects of ionization, and star cluster evolution. Remarkably, simulators get about the same results as observers: power law structures and mass functions are reproduced in computers, filaments, clumps and disks are all present, the timescale for star formation comes out about right, and the overall efficiency of turning gas into stars is also right.

Still there are many details that need to be evaluated. In fact, the first two decades of simulations look almost too good in retrospect. When realistic heating and windy feedback are included, the stellar mass function sometimes changes in seemingly unacceptable ways. The full complexity of magnetic processes is not yet modeled either. Different magnetic field configurations could affect the binary fraction and disk sizes. Processes such as ion-molecule-radiation chemistry that determine the ionization fraction and rate of diffusion are not in computer codes, nor is magnetic reconnection. Radiative transfer through complex gas structures has barely begun. There is still a lot to do.

IAU Symposium No. 270 was convened to bring us up to date on the state of our field. We selected Barcelona (the capital of Catalonia) because of its beautiful climate, famous architecture, and friendly citizens, and we were not disappointed. The Symposium was attended by 220 scientists from 31 countries between May 31st and June 4th, 2010. Almost all of our time was packed with talks and discussions, even in two evening sessions when tapas and drinks were provided to keep us going. We visited the Mare Nostrum Supercomputer Center and had a wonderful excursion to the Codorniu and Freixenet

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Caves winery with a sumptuous banquet at the Masia Torreblanca. We were all saddened to hear that one of the evening entertainers, Lluis Barrera Torné, leader of the acrobatic troupe "Colla Castellera Xicots de Vilafranca" that thrilled us with towering human pyramids, met an untimely death in a motorcycle accident only 2 months later.

It is a great pleasure to acknowledge the support of the IAU and all of the hard work by the SOC and LOC. We are deeply grateful to our invited and contributing speakers who wrote this book. The posters from the conference may be viewed at the Cambridge University Press website.

November 2010

Bruce G. Elmegreen, Virginia Trimble, João Alves, and Josep Miquel Girart
SOC co-chairs (pictured below at the reception)

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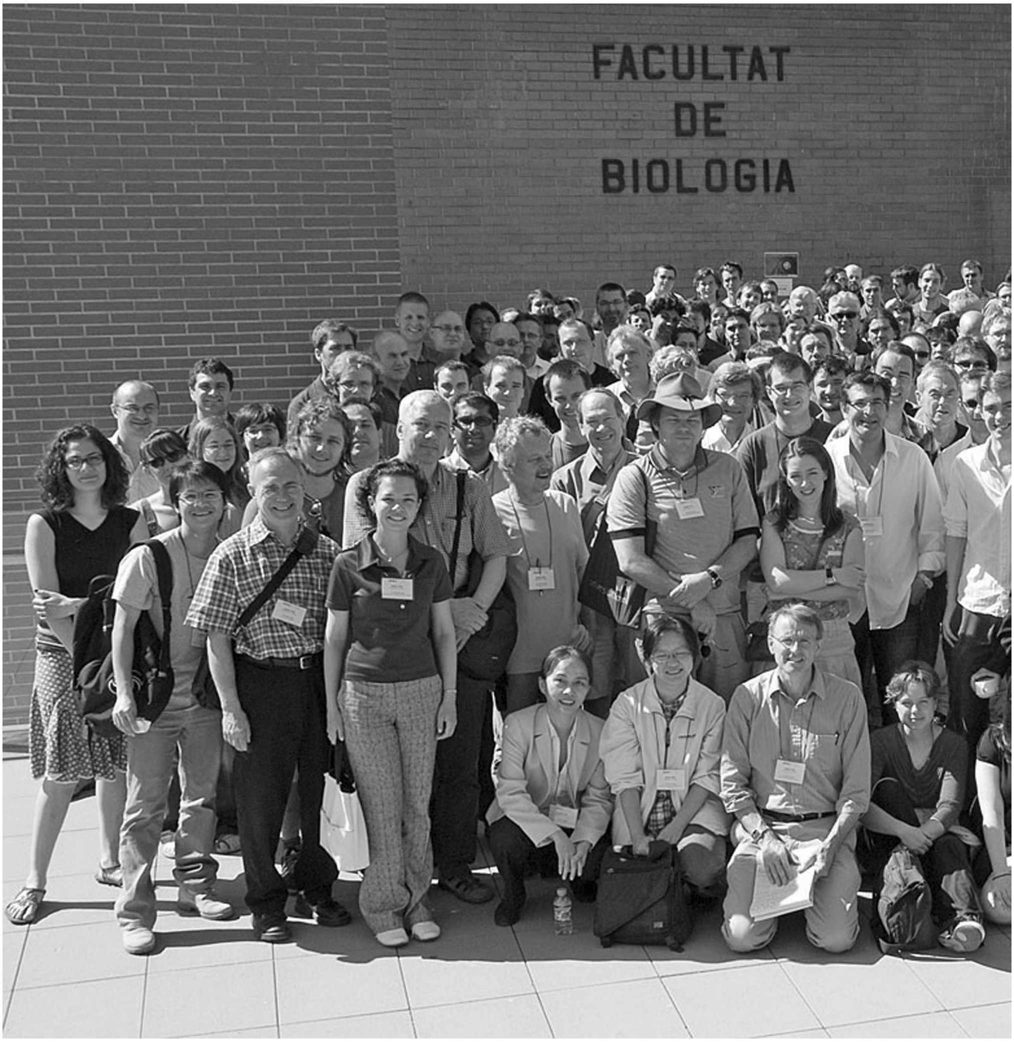

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