

Preface

In the last few years it has become clear that the modelling of star formation and feedback processes is central to the quest of finding solutions to the key problems of galaxy formation. A complete story of star formation and its connection with the cosmic evolution of our Universe requires to study physical processes taking place at very different scales.

At cosmological scales the gas is sparse and highly ionized. Its temperature depends on the subtle balance between photo-heating and adiabatic as well as radiative cooling. In the densest regions, following the growth of the cosmological fluctuations, it may be accreted onto forming and evolving galaxies. At the galactic scale, the physics becomes extremely complex, non-linear and far from equilibrium. The interstellar medium is composed of a mixture of charged particles, atoms, molecules and dust grains. There, turbulent cascades drive the formation of cloud complexes of various sizes and masses, from which stars may eventually form. The collapse of these complexes is ultimately halted by star formation, resulting in a system intricately linked together through a variety of feedback loops.

Due to the numerous complex and interleaved process involved, modelling the star formation is challenging. The theory and numerical models of star formation have traditionally evolved independently from those of galaxy evolution, because they act at different spatial scales. We are now at a point however, where substantial steps forward can only arise from the combined knowledge of these two research fields.

The goal of the 43rd *Saas-Fee Advanced Course* was to bring together, in a single place, these two fields. It aimed to take an inventory of the physical processes related to the star formation involved at different scales and also to provide an overview of the major computational techniques used to solve the equations governing self-gravitating fluids, essential to galactic modelling. Together this provides a unique framework essential to developing and improving the simulation techniques used to understand the formation and evolution of galaxies.

The lack of a textbook joining these different fields motivated the members of the Swiss Society for Astrophysics and Astronomy to vote in favour of the

organisation of a winter Saas-Fee course on the star formation in galaxies and its modelling techniques.

The three selected lecturers—Nickolay Gnedin, Ralf Klessen and Volker Springel—succeeded in bringing to the 95 participants a very rich and interesting review of the fields related to the star formation in galaxies. An invaluable additional contribution came later from Simon Glover who participated in the writing of the chapter dedicated to the physical processes in the interstellar medium. The reader can revel now those lectures in the following pages. The present book is supplemented with the complete video recordings of the lectures, which are accessible online, via the 43rd *Saas-Fee Advanced Course* website: <http://lastro.epfl.ch/conferences/sf2013/>.

We are very grateful to the lecturers for their invaluable live lectures as well as for their written version presented here. We are particularly thankful to Prof. Georges Meylan, Head of the Laboratory of Astrophysics at EPFL, who supported the organisation at all stages, making this course a success. We are extremely grateful to Matthew Nichols, who video-recorded the lectures and post-processed the movies. Olivier Genevay has been at the heart of all practical arrangements without counting his time; we want to thank him very warmly. We also thank the course secretaries, Carol Maury and Claire Schatzmann, as well as our colleagues, Malte Tewes, Vivien Bonvin, Alexis Arnaudon and Daniel Pfenniger for all their help in the practical organisation of the course.

The course took place during winter in the village of Villars-sur-Ollon in the Alps of Switzerland. While benefiting from superb weather after some snowy days, a conference picture was kindly taken by Ievgen Vovk and is displayed below.

Yves Revaz
Pascale Jablonka
Romain Teyssier
Lucio Mayer



Star Formation in Galaxy Evolution: Connecting
Numerical Models to Reality

Saas-Fee Advanced Course 43. Swiss Society for
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Gnedin, N.Y.; Glover, S.C.O.; Klessen, R.S.; Springel, V. -
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