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Origins: From the Protosun to the First Steps of Life

Edited by

Bruce G. Elmegreen
L. Viktor Tóth
Manuel Güdel

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COVER ILLUSTRATION:

View of the Earth and Moon from the Galileo spacecraft, 6.2 million kilometers away, on its way to Jupiter in 1992 (credit: NASA). The Earth, filled with water, air, and abundant life, shines brilliantly in stark contrast to its nearest neighbor.

Carl Sagan and collaborators used measurements from this spacecraft as it flew by the Earth to see if they could detect evidence for intelligent life.

(C. Sagan, W. R. Thompson, R. Carlson, D. Gurnett, and C. Hord 1993, "A search for life on Earth from the Galileo spacecraft," Nature, Volume 365, Issue 6448, pp. 715-721)

"There are countless suns and countless earths all rotating round their suns in exactly the same way as the seven planets of our system. We see only the suns because they are the largest bodies and are luminous, but their planets remain invisible to us because they are smaller and non-luminous. The countless worlds in the universe are no worse and no less inhabited than our earth. For it is utterly unreasonable to suppose that those teeming worlds which are as magnificent as our own, perhaps more so, and which enjoy the fructifying rays of a sun just as we do, should be uninhabited and should not bear similar or even more perfect inhabitants than our earth. The unnumbered worlds in the universe are all similar in form and rank and subject to the same forces and the same laws." - Giordano Bruno (1548-1600), as quoted in *The Discovery of Nature* (1965), by Albert W. Bettex, London, Thames and Hudson Publishers.

One of the questions addressed in this symposium is whether the "countless earths" envisioned by Giordano Bruno have any "inhabitants" at all. This question seems much more complex than anyone could have imagined.

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Chief Editor
PIERO BENVENUTI, IAU General Secretary
IAU-UAI Secretariat
98-bis Blvd Arago
F-75014 Paris
France
iau-general.secretary@iap.fr

Editor
MARIA TERESA LAGO, IAU Assistant General Secretary
Universidade do Porto
Centro de Astrofísica
Rua das Estrelas
4150-762 Porto
Portugal
mtlago@astro.up.pt

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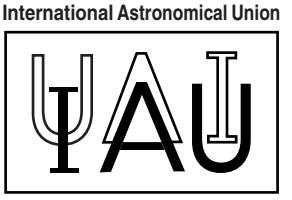

ORIGINS: FROM THE PROTOSUN TO THE FIRST STEPS OF LIFE

PROCEEDINGS OF THE 345th SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN VIENNA, AUSTRIA 20–23 AUGUST, 2018

Edited by

BRUCE G. ELMEGREEN
IBM T.J. Watson Research Center, USA

L. VIKTOR TÓTH
Eotvos Lorand University, Budapest, Hungary

and

MANUEL GÜDEL
University of Vienna, Austria

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Preface

Understanding the origin of the Sun, the Earth and how life began on Earth are some of the most challenging and interesting problems facing the science community today. With the goal of addressing many of the complex processes involved, the Scientific Organizing Committee put together this Symposium 345 at the General Assembly of the International Astronomical Union in Vienna, Austria. The meeting, held on 20-24 August 2018, had 10 invited talks, 37 contributed talks, and 151 posters, with 190 registered attendants from 34 countries. The General Assembly also included a Plenary talk on this topic by one of us (MG) and a summary of highlights from the Symposium by a second (LVT) at Division H Days.

The symposium spanned many disciplines in astronomy, planetary science, and astrobiology, following the chain of events that could have been involved in the formation of the Earth and the earliest life forms. Many steps in this process have been inferred from detailed observations and computer models. Stars form in dense interstellar clouds and are usually clustered together. The environment of the early Sun should have been affected by that clustering, as suggested by the isotopic composition of meteorites. Protoplanetary disks that may form Earth-size planets have been studied at high resolution in infrared and radio wavelengths. These observations reveal the chemistry and dust content of the disks, and possible interactions with the growing planets.

While there are no direct observations yet of Earth-size *proto*planets, there is evidence for fully-formed Earth-size planets around other stars, and there are clues to the formation process of the Earth itself from within our Solar System. New models, complemented by observations of exoplanets and solar-system planets, have revealed an important role for the host star's energy output for processing and eroding planetary atmospheres. The conditions for habitability are more difficult to observe and model. How these conditions arose and the nature of the first organisms are topics of intense study.

An accompanying summer school, "Basics of Astrobiology," was held at the University of Vienna on the two days prior to the General Assembly, 17-18 August 2018. There were approximately 100 attendees and 11 speakers. The talks are on www.youtube.com.

– Bruce G. Elmegreen, L. Viktor Tóth, Manuel Güdel, co-chairs SOC, March 2019

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Editors

Bruce G. Elmegreen
IBM T.J. Watson Research Center, USA

L. Viktor Tóth
Eötvös Loránd University, Budapest, Hungary

Manuel Güdel
University of Vienna, Austria

Scientific Organising Committee

SOC Co-Chairs

Bruce G. Elmegreen	(IBM T. J. Watson Research Center, USA)
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Participants

Abraham, Peter
Abrevaya, Ximena C.
Ackerl, Christine
Aikawa, Yuri
Airapetian, Vladimir
Akimkin, Vitaly
Alfaro, Emilio J.
Alvarado Gomez, Julian David
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Lammer, Helmut
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Leitzinger, Martin
Li, Di

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Li, Ji
Li, Yaping
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