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Guest Editorial

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Frank Drake introduced the equation that now bears his name in November 1961 at a conference entitled *Extraterrestrial Intelligent Life and Interstellar Communication: An Informal Discussion* held at the National Radio Astronomy Observatory (NRAO) in Greenbank, West Virginia. The conference was co-organized by Frank Drake and J. P. T. Pearman and marked the birth of the Search for Extraterrestrial Intelligence (SETI). The equation proposed by Frank Drake aimed at organizing the debate by distinguishing seven factors controlling the number N of civilizations present in our galaxy, $N = R^* f_p n_e f_l f_i f_c L$ (see the accompanying box).

Fifty years later, on November 21st and 22nd, 2011, a workshop entitled *Drake Equation* was held at Centre National d'Études Spatiales (CNES) headquarters in Paris to review the progress accomplished in the intervening years. Knowledge on some of the factors involved in the equation had significantly increased and a fresh discussion of the subject was timely. The workshop gathered 85 participants coming from various disciplines – astrophysics and planetology, chemistry, biology, anthropology and philosophy. Eighteen talks were presented that promoted lively discussions and led to the exploration of new ideas about the presence of, and search for other civilizations in the galaxy.

Participants in the workshop were expected to cover the various terms of the equation in four different sessions: (1) Exoplanets and Habitability, topics that deal with the first three factors of the equation; (2) Origin and Evolution of Life and Intelligence, dealing with the 3rd, 4th and 5th factors; (3) Evolution of Extraterrestrial Civilizations and Technologies of communication, about the 6th and 7th factors; (4) Epistemology and open questions.

This special issue of the *International Journal of Astrobiology* offers a selection of nine papers that were presented at the workshop. These articles illustrate how a cross-section of researchers interested in the origin and evolution of life and intelligence in the universe approaches this intriguing subject. All the diverse and related topics analyzed at the workshop were considered. In this issue, the articles are organized in four parts.

The First Part is devoted to the astronomical and biological factors. François Forget deals with the terms f_p, the fraction of stars that form planets, and n_e, the number of planets hospitable to life orbiting those stars. His paper "*On the probability of habitable planets*" discusses the question of habitability in the light of the recent discoveries related to exoplanets. In "*Trends in the evolution of life, brains and intelligence*", Jean-Pierre Rospars considers factor f_i, the fraction of planets where life evolves into intelligent beings. He shows that evolutionary trends are real and important for assessing factor f_i. Based on this evidence, he discusses the current opinion among leading evolutionary biologists that evolution is not repeatable.

The Second Part deals with the terms f_c, the fraction of planets with intelligent beings capable of interstellar communication, and L, the length of time that a communicative civilization remains detectable. In "*New SETI prospects opened up by current information networking*", Elisabeth Piotelat and Florence Raulin Cerceau focus on f_c. They argue that a new civilization has emerged on Earth due to recent improvements in computing technology and stress its importance for SETI. Luc Arnold's paper "*A comparison between classical and alternative SETI in the context of the Drake equation*" compares classical SETI (radio waves) to alternative SETI (optical lasers, artificial transits) and combines this comparison to a study of L.

Papers in the Third Part adopt a global approach involving all factors in the equation. In "*SETI, evolution and human history merged into a mathematical model*", Claudio Maccone proposes a new mathematical model capable of merging SETI and Darwinian evolution into a single mathematical scheme based on exponential and lognormal probability distributions. In "*A joint analysis of the Drake equation and the Fermi paradox*", Nicolas Prantzos proposes a unified framework for studying quantitatively the Drake equation and the Fermi paradox; it allows him to define for which values of L and other factors the Fermi paradox definitely holds.

The Fourth Part considers historical, epistemological and philosophical aspects. Danielle Briot reviews in "*Elements for the history of a long quest: search for life in the Universe*" the main steps of the history of Astrobiology, from Antiquity to the Drake equation and points out unrecognized papers published during the 20th century. In "*Problems with the definition of extraterrestrial life and intelligence*", Jean Schneider attempts to clarify the difficult notions of "life" and "intelligence" and calls attention to the pitfalls resulting from preconceptions in our language. Finally, in "*Communication with Aliens as an opening of the Horizon of a scientific Humanity*", Jean-Luc Petit contemplates the motives underlying the search for extraterrestrial intelligent life. He stresses two powerful motives, transcendental and anthropological, whose interaction could lead to a confused understanding of SETI.

The workshop was organized under the auspices of French National Center for Space Studies (CNES), the International Academy of Astronautics (IAA) and the Société Française d'Exobiologie (SFE). We are very grateful to these institutions for their contribution to the success of the workshop. We also thank the members of the scientific committee: Alain Labèque (IAS, Orsay), Elisabeth Piotelat (LIMSI, Orsay) and Jean-Michel Martin (Observatoire de Paris-Meudon), who helped us to chair the workshop, as well as Luc Arnold (Observatoire de Haute Provence), André Brack (Centre de Biophysique Moléculaire, Orléans), Didier Despois (Observatoire Aquitain des Sciences de l'Univers, Bordeaux), Nicolas Prantzos (Institut d'Astrophysique de Paris), and Jean Schneider (Observatoire de Paris-Meudon), who contributed in many other ways. Finally, we dedicate this Special Issue to Frank Drake who pioneered research in this field and shows convincingly in his Preface that the most exciting discoveries framed in his Equation still lay in the future.

DRAKE EQUATION

How can we estimate the number of technological civilizations that might exist among the stars? In 1961, while working as a radio astronomer at the National Radio Astronomy Observatory in Green Bank, West Virginia, Dr. Frank Drake conceived an approach to estimate the number of technological civilizations that may exist in our galaxy. The Drake Equation, as it has become known, identifies seven specific factors thought to play a role in the development of such civilizations. The equation is usually written:

$$N = R^* f_p n_e f_l f_i f_c L$$

where,

N = The number of civilizations in The Milky Way Galaxy whose electromagnetic emissions are detectable.
R^* = The rate of formation of stars suitable for the development of intelligent life.
f_p = The fraction of those stars with planetary systems.
n_e = The number of planets, per solar system, with an environment suitable for life.
f_l = The fraction of suitable planets on which life actually appears.
f_i = The fraction of life bearing planets on which intelligent life emerges.
f_c = The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.
L = The length of time such civilizations release detectable signals into space.

Based on http://www.seti.org/drakeequation

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