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RADIO EMISSION FROM MASSIVE PROTOSTELLAR OBJECTS

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RESUMEN

El estudio de la formación de estrellas masivas presenta aún hoy complejos desafíos, tanto teóricos como observacionales. Las fases más tempranas son, en particular, de las que menos información se tiene ya que sólo se detectan en longitudes de ondas milimétricas (mm) y sub-mm. Aquí se describe lo que aportan los datos en radiondas, se resumen trabajos, y se discute la estrecha conexión entre los procesos a bajas y altas energías. Para terminar, se detallan brevemente fuentes alternativas de datos disponibles, a la luz de nuevos relevamientos.

ABSTRACT

The study of the formation of massive stars present complex challenges from both theoretical and observational points of view. The initial phases of evolution, for instance, remain almost hidden except at radio and IR wavelengths. In this article, after stating some of the problems of massive star formation, the role of radio observations to disclose the involved physics is discussed. Historical observational findings are briefly outlined, and the connection between low energy and high energy aspects of the phenomenon is addressed. Finally, data availability in the form of some new surveys is reported.

Key Words: H II regions — ISM: jets and outflows — stars: pre-main sequence — stars: mass loss

1. INTRODUCTION

Massive stars ($M_* \geq 8\ M_\odot$) are formed at the cores of dense molecular clouds with very low temperatures and very high densities (for a thorough discussion of the star-formation theories the reader is referred to the recent review of McKee & Ostriker 2007). These clouds remain undetectable except at radio and near-IR wavelengths. It was not until the last decade that the angular resolution of the observing instruments improved significantly enough to allow a deep study of these almost-obscure regions. Figure 1 depicts a stellar-rich southern-sky star-forming region (SFR).

The exact steps that lead to the formation of a high-mass star are not completely understood. The basic ingredients of the global process are the following ones. The gravitational collapse inside the cold cloud gives rise to an initial condensation that will become a protostar. Because of its angular momentum, the surrounding gas is accreted onto the protostar, forming a disk. The twisting of the magnetic field that pervades the region causes the protostellar object to eject matter, in the form of collimated polar jets of plasma (e.g. Arce et al. 2007). These jets propagate to large distances (pc) and interact with the interstellar medium (ISM), sweeping neutral gas in their path. Eventually, the piled up material stops the gas flow, forming a Herbig-Haro object. Only in the case of massive stars, the density of the central object is large enough to ignite nuclear reactions before the accretion comes to an end.

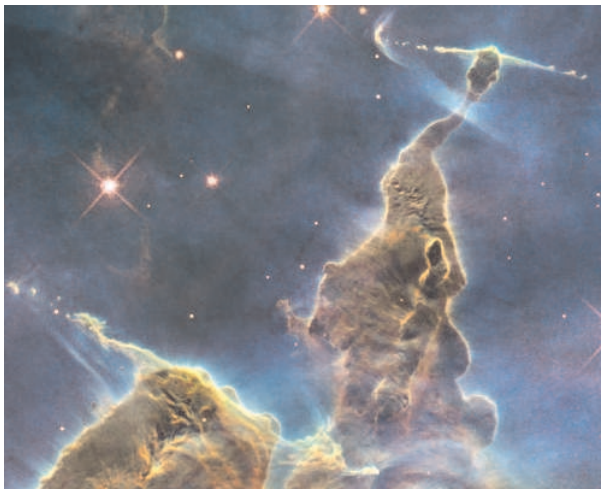

Fig. 1. Star-forming pillars and protostellar objects at the Carina nebula. Credit: NASA, ESA, and M. Livio and the Hubble 20th Anniversary Team (STScI).

Figure 2 is a sketch of a star-forming molecular cloud, with a variety of components. An extremely rich phenomenology can be appreciated.

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