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Star forming regions with indication of hierarchical structure in a sample of spiral galaxies

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Abstract. The presence of small and large scale star formation structures in a sample of six spiral Hubble Space Telescope (HST) galaxies has been investigated. Our main goal is to identify small structures of young stars known as OB associations and to investigate whether they are formed inside larger scale star forming stellar structures in a hierarchical form. This process was based on a friend of friend (FOF) algorithm applied on the bright early type stars above a certain color cutoff limit in order to ensure that we include mainly main sequence stars. A size criterion was introduced in order to apply the same algorithm to different types of stellar structures. Depending on their size the structures were divided into the four categories, associations, aggregates, complexes and supercomplexes. Star forming structures of the four types mentioned above are found in all six galaxies of our sample. The majority of the associations and aggregates (the smaller structures) found are lying inside larger structures like complexes and supercomplexes, indicating an hierarchical star formation mechanism.

1. Introduction

The six galaxies studied were part of the HST Extragalactic Distance Scale Key Project (Kennicutt, Freedman & Mould, 1995). All images used for our purpose were taken with the Wide Field and Planetary Camera 2 (WFPC2). Data, were taken using HST/WFPC2 images and filter F555W (V) and F814W (I) and were retrieved from the HST data archive. The data were reduced using the HSTphot photometry package (Dolphin 2000).

2. Method

A FoF algorithm based on the PLC principles, Battinelli (1991), was applied to the bright star catalog of each galaxy. Two stars belong to the same group only if they are at a distance less or equal to a predefined search radius (Ds). There are two important issues to be addressed, the value of Ds for which our star catalog will be investigated and the detection of structures larger than associations and aggregates. In order to address the latter another criterion was introduced in the identification process, the size of the structures found. We

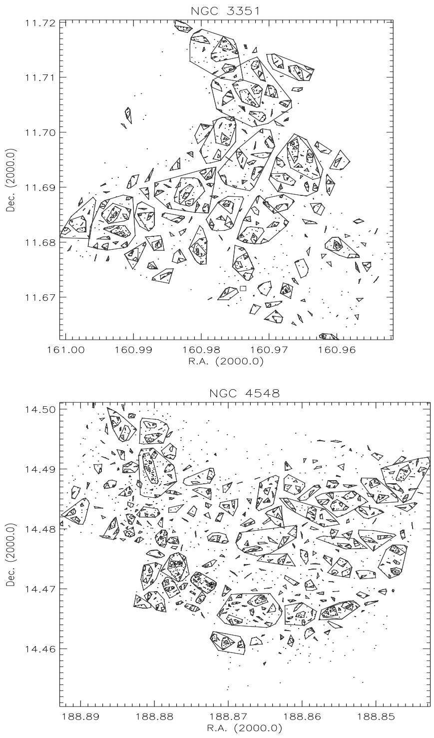

Fig. 1. Plots of star forming regions in NGC 3351 and NGC 4548.

divided the stellar structures into the four main types introduced by Efremov (1987). The algorithm now instead of investigating for the total number of structures for a given Ds value, is searching the catalog for each of the four types of structures using the size criterion. Therefore instead of one Ds value now we use four, one for each structure type.

3. Conclusions

- The detected groups are found within the size range reported in the literature.
- The size distribution of associations peaked in the range 50-80 pc for the whole galaxy sample.
- The average size found for each structure category is 66 pc for asscociations, 165 pc for aggregates, 500 pc for complexes and 1400 pc for supercomplexes (Figure 1).
- The surface density of groups seems to correlate with the group type.
- In all galaxies that were studied, most of the associations and aggregates, the smaller and denser groups, are found to be lying inside larger groups, complexes and supercomplexes, which present the lower density values of all groups, indicating a hierarchical form of structure in the star formation process (Elmegreen & Efremov 1996; Maragoudaki et al. 2001; Livanou et al. 2006; Karampelas et al. 2009).
- In Figure 1 the mapped structures of two galaxies of the sample are presented. Structures in NGC 3351 trace the spiral arm extended away from the nucleus from north to south (top to the bottom) and likewise in NGC 4548 the identified structures trace the spiral arm from east to west (left to right).

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