Determining the Initial Mass Function, Star Formation Rate and local Stellar Kinematics

by

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Declaration of Authorship

I, Steven Dawson, declare that this thesis titled, 'Determining the Initial Mass Function, Star Formation rate and local Stellar Kinematics' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.

- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.

- Where I have consulted the published work of others, this is always clearly attributed.

- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.

- I have acknowledged all main sources of help.

- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

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Date:

_____

"If all I now understand was represented by the mass of the Earth, all there is to understand would be represented by the mass of the Universe..... Lets hope Dark Matter does not exist!"

UNIVERSITY OF GUANAJUATO

Abstract

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0.1 En *Español*

En el presente trabajo, se determin*ó* la Funcin Inicial de Masa (IMF, por sus siglas en Ingl*és*) mediante el estudio de la cinem*á*tica y taza de formaci*ó*n estelar de la vecindad solar. Esto se logr*ó* comparando muestras sint*é*ticas y datos observacionales por medio de conteos de estrellas.

Muchos estudios previos, se haban concentrado s*ó*lamente en estrellas de Secuencia Principal (Binney & Aumer 2009, Cignoni et al. 2006), por tanto, información sensible a la edad embebida en estrelas mas evolucionadas, se haba dejado de lado. Este hecho fue expuesto por Schröder & Pagel (2003), sin embargo, su estudio careci*ó* de información sobre la fracci*ó*n de sistemas binarios y de la incompletez residual de su muestra. Con el advenimiento de nuevos datos, se puede mejorar en estas cuestiones.

La primera de las mejoras proviene del uso de un cat*á*logo mucho mas completo de estrellas binarias (Washington Double Star catalogue). Usando tal cat*á*logo,se pueden determinar factores de correcci*ó*n en los conteos de estrellas simples en casos de binarias no conocidas, las cuales incrementan su nmero a baja luminosidad y distancia. Esto nos permiti*ó* tambi*é*n probar la hip*ó*tesis que la fracci*ó*n de binarias decrece en funci*ó*n de la masa primaria (Lada 2006).

La segunda mejora viene de una nueva reducci*ó*n de los datos de Hipparcos (Van Leeuwen, 2007). Esto ha reducido errores de paralaje particularmente hacia estrellas rojas, lo cual permite reducir el sesgo de tipo Malmquist (Malmquist 1936) y por tanto nos permite sondear m*á*s estrellas evolucionadas en mayores vol*ú*menes. El uso de mayores vol*ú*menes nos brindadn una mejor determinacin de la IMF para estrellas de alta masa.

La tercera mejora viene de una relacin derivada semi-empricamente de la "escala de altura". Esto reduce el n*ú*mero de par*á*metros de entrada en los modelos y asegura que las muestras sint*é*ticas tengan una mayor base cientfica.

Después de haber modelado la muestra local de estrellas visibles simples, fue posible entonces generar una muestra sintética de Enanas Blancas para comparación con una muestra casi completa de Enanas Blancas fras (Holberg et al 2008). Lo anterior nos permitió demostrar que a la muestra de Holberg le faltan enanas blancas y sistemas binarios no-resueltos. Otra posible interpretación de este hecho es que la fracción de binarias decrece como función de la edad debido a la fusión que tales sistemas sufren en su evolución. Esta teora va encaminada de alguna forma a resolver un tema muy discutido (Weidemann 1977) que tiene que ver con el déficit de Enanas Blancas encontrado en cúmulos de estrellas en comparación con sus contra-partes en la Secuencia Principal.

0.2   In *English*

The Kinematics and Star Formation Rate of the solar neighbourhood have been re-established in order to better determine the Initial Mass Function. This has been accomplished by modeling synthetic samples of stars and comparing them to observational data using the star count method.

Many previous studies have concentrated solely on main sequence stars (Binney & Aumer 2009, Cignoni et al. 2006) and have thus neglected the age-sensitive information embedded within the evolved stars. This improvement has been researched by Schröder & Pagel (2003) however, they lacked information on the binary fraction and the residual incompleteness of their sample. With the advent of new data these issues can be improved upon.

The first such improvement comes from a much more complete catalogue of binary stars (Washington Double Star catalogue). From this we are able to determine the number of unrecognized binaries, which increase with lower luminosity and distance and make the appropriate corrections. This has further enabled us to test the hypothesis that the binary fraction decreased as a function of the primary mass (Lada 2006).

The second improvement has been a new reduction of the Hipparcos data (Van Leeuwen, 2007). This has reduced the parallax errors particularly towards the redder stars thus enabling a reduction in the Malmquist-type bias (Malmquist 1936), allowing for a larger volume containing more evolved stars to be probed. This larger volume enables a better determination of the IMF for large mass stars.

The third improvement comes from a semi-empirically derived scale height-age relationship. This reduces the number of input parameters to the models and ensures the synthetic samples to have a greater scientific basis.

After the local sample of visible single stars was modeled it was then possible to generate a synthetic sample of White Dwarfs for comparison with an almost

complete sample (Holberg et al 2008). By doing so it was possible to show that the Holberg sample is missing a number of cool White Dwarfs and unresolved binary systems. Another interpretation of this is that the binary fraction decreases as a function of age due to such systems merging during evolution. This theory goes some way to resolving the long standing issue (Weidemann 1977) of the deficit of White Dwarfs found in clusters when compared to their Main Sequence counterparts.

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