GCfit

Globular Cluster Observation Data

Data File Catalog

Version 2 January 18, 2022

1 Introduction

All datasets are stored in a 'Hierarchical Data Format' (HDF5) file.

A data group[1] must contain all data representing a single observational product, that is, all datasets associated to a single physical process, from a single source, along with all relevant metadata.

All data corresponding to a single data group should exist within the relevant 'key' group (given below) under the file root group, which corresponds to a physical process or observable. If multiple groups exist covering the same observation type (Ex: Multiple different sources observing proper motion profiles) Then those groups must exist as further subgroups within the 'key' group (Ex: `/proper_motion/sourceA/` and `/proper_motion/sourceB/`). However, all subgroups must exist within the key at the same level. No unequal nesting or shared space is allowed.

Each group has a number of required datasets, which are detailed below. Each dataset may have required supplementary datasets as well, such as uncertainties. Each dataset may also require certain metadata fields, such as unit names, to be stored as attributes on the dataset itself.

2 Attributes

Overall cluster attributes and metadata are stored as attributes to the file root group. Certain attributes are required for fitting certain observables. Some attributes, when required for model creation, are given default values, if they do not exist in the file. All attributes stored must correspond to the units given below as they will be assumed at runtime.

Variable	Attribute Name	Notes	Default Value	Units
Galactic Longitude	`l`	Required for pulsar fitting	N/A	degrees
Galactic Latitude	`b`	Required for pulsar fitting	N/A	degrees
Right Ascension	`RA`	Required for mass function fitting	N/A	degrees
Declination	`DEC`	Required for mass function fitting	N/A	degrees
Metallicity [Fe/He]	`FeHe`	Defines mass function evolution	-1.00	dex
Age	`age`	Defines mass function evolution	12	Gyr
Total Proper Motion	μ	Required for pulsar fitting	N/A	mas/yr
Total escape rate $\dot{N}$	`Ndot`	Defines mass function evolution	0	

[1]Contrary to HDF standards, in all project documentation a 'Dataset' does not refer to the typical HDF dataset, but is analogous to a specific HDF group while 'Variable's are most analogous to HDF datasets. In this document, the standard HDF group/dataset notation will be used.

key: `/initials`

All 13 usual free parameters are given initial values. These values act as the initial parameter positions in some sampling routines, and as the given value of a parameter, if it is fixed during sampling.

Initial values are stored as attributes to this group. Any parameters which are not stored here are given default values, listed below.

Variable	Attribute Name	Description	Default Value
W_0	`W0`	Central potential	6.0
M	`M`	Total cluster mass [$10^6 M_\odot$]	0.69
r_h	`rh`	Half-mass radius [pc]	2.88
$\log(r_a)$	`ra`	Anisotropy radius [$\log(pc)$]	1.23
g	`g`	Truncation parameter	0.75
δ	`delta`		0.45
s^2	`s2`	Velocity scale nuisance parameter	0.1
F	`F`	Mass function nuisance parameter	0.45
a_1	`a1`	1st mass function power law exponent	0.5
a_2	`a2`	2nd mass function power law exponent	1.3
a_3	`a3`	3rd mass function power law exponent	2.5
BH_{ret}	`BHret`	Black hole initial retention fraction	0.5
d	`d`	Cluster distance [kpc]	6.405

3 Data Products

* denotes required fields

3.1 Pulsar Accelerations

key: `/pulsar`

3.1.1 Datasets

Variable	Dataset Name	Supplementary Datasets	attributes
Radial distance	r*		unit
Spin period	P*	ΔP	unit
Spin period derivative	Pdot_meas*	ΔPdot_meas*	unit
Orbital period	Pb*	ΔPb	unit
Orbital period derivative	Pbdot_meas*	ΔPbdot_meas*	unit
Dispersion Measure	DM	ΔDM	unit
Pulsar identifier	id		

Pulsars can be fit on the timing solutions of both the isolated pulsar spin (P, Pdot_meas) and the binary systems orbit (Pb, Pbdot). The period, derivative and corresponding errors are required for either. Optionally, the dispersion measure (DM) can be used to provide a better acceleration constraint, where available.

3.1.2 Attributes

Attribute	Description
source	Literature source(s) of data
m	Mean stellar mass of tracer stars [$M_\odot$]

3.2 Number Density

key: `/number_density`

3.2.1 Datasets

Variable	Dataset Name	Supplementary Datasets	attributes
Radial distance	r*		unit
Number Density	Σ*	ΔΣ*	unit

3.2.2 Attributes

Attribute	Description
`source`	Literature source(s) of data
`m`	Mean stellar mass of tracer stars [$M_\odot$]

3.3 Proper Motions

key: `/proper_motion`

3.3.1 Datasets

Variable	Dataset Name	Supplementary Datasets	attributes
Radial distance	`r`*	Δ`r`	`unit`
Total proper motion	`PM_tot`*	Δ`PM_tot`*	`unit`
Proper motion ratio	`PM_ratio`*	Δ`PM_ratio`*	`method`
Radial proper motion	`PM_R`*	Δ`PM_R`*	`unit`
Tangential proper motion	`PM_T`*	Δ`PM_T`*	`unit`

The proper motions can be fit on any of these components, alone or as a group. The corresponding errors are required for any.

3.3.2 Attributes

Attribute	Description
`source`	Literature source(s) of data
`m`	Mean stellar mass of tracer stars [$M_\odot$]

3.4 Velocity Dispersions

key: `/velocity_dispersion`

3.4.1 Datasets

Variable	Dataset Name	Supplementary Datasets	attributes
Radial distance	`r`*		`unit`
LOS velocity dispersion	σ^*	$\Delta\sigma^*$	`unit`

3.4.2 Attributes

Attribute	Description
`source`	Literature source(s) of data
`m`	Mean stellar mass of tracer stars [$M_\odot$]

3.5 Mass Functions

key: `/mass_function`

3.5.1 Datasets

Variable	Dataset Name	Supplementary Datasets	attributes
Number of stars	`N`*	Δ`N`*	
Radial bin inner bound	`r1`*		`unit`
Radial bin outer bound	`r2`*		`unit`
Mass bin inner bound	`m1`*		`unit`
Mass bin outer bound	`m2`*		`unit`
Observation fields	`fields`*		See caption

The `fields` dataset is an empty dataset and exists only as a container for it's attributes. Each mass function will have some number of field boundary polygon attributes, each denoted by a single alphanumeric character (a, b, c, etc.). Each attribute consists of a 2d-array of (RA, DEC) coordinates which define the polygonal boundaries of this observation

3.5.2 Attributes

Attribute	Description
`source`	Literature source(s) of data
`field_unit`	Coordinate units of all `fields` boundaries