Models of Faint Galaxy Production through Star Cluster Evolution

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Sizes of low-mass stellar systems

Models of Faint Galaxy Production through Star Cluster Evolution
Sizes of low-mass stellar systems

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Sizes of low-mass stellar systems

MW

M31

M31 dIrr

Huxor+11

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Sizes of low-mass stellar systems

MW
M31

M31
dlrr

DM halo

MW
M31

Sizes of low-mass stellar systems

Huxor+11

MW
M31

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**Equation of Motion**

\[
\ddot{r}_i = -G \sum_{j=1}^{N} \frac{m_j (r_i - r_j)}{|r_i - r_j|^3}
\]

\[O(N^3)\]

\[\rightarrow \text{special-purpose GRAPE} \text{ hardware}\]

\[\rightarrow \text{GPU}\]

\[\text{stellar evolution}\]

\[\text{binary evolution}\]

\[\text{techniques for few-body subsystems}\]

\[\text{tidal field}\]

[ NBODY4/NBODY6: Aarseth 1999; Aarseth 2003]

[Hurley et al. 2001]

[Mardling & Aarseth 2001; Mikkola 2006, etc.]
Models of Extended Clusters?

$N = 100,000$, 5% binaries, $Z = 0.001$, KTG IMF, Plummer/King
Models of Extended Clusters?

\( N = 100,000, \text{ 5\% binaries, } Z = 0.001, \text{ KTG IMF, Plummer/King} \)

\( R_{GC} = 10 \text{ kpc} \)

\( M_G = 9 \times 10^9 \, M_{\odot} \) point-mass
\( M = 9 \times 10^{10} \, M_{\odot} \) point-mass or 3-component

\( e.g. \, NGC6822 \)
\( e.g. \, M31 \)
Models of Extended Clusters?

$N = 100,000$, 5% binaries, $Z = 0.001$, KTG IMF, Plummer/King

e.g. NGC6822  e.g. M31

![Graphs showing the evolution of clusters over time](graphs.png)
Models of Extended Clusters?

$N = 100,000, 5\%$ binaries, $Z = 0.001$, KTG IMF, Plummer/King

Hurley+Mackey10

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Models of Extended Clusters?

Da Costa+09

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Models of Extended Clusters?

Da Costa+09
The $N = 200,000$ model

200k
2% binaries
$R_{gc} = 4$ kpc

100k
5% binaries
$R_{gc} = 8.5$ kpc
Models of Ultra-Faint Dwarfs?

\[ \text{Mass within 300 pc (M}_\odot) \]

\[ \text{Luminosity (L}_\odot) \]

\[ \text{sigma} \sim 3-10 \text{ km/s} \]

Strigari+08
Models of Ultra-Faint Dwarfs?

\[ M_{\text{NFW}} = 10^9 \]
\[ c = 16 \]
\[ R_{\text{gc}} = 0.5 \text{ kpc} \]
Models of Ultra-Faint Dwarfs?

$M_{\text{NFW}} = 10^9$

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Models of Ultra-Faint Dwarfs?

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$M_{\text{NFW}} = 10^9$
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Models of Ultra-Faint Dwarfs?

Star cluster near centre ($R_{gc}=20pc$), $M_{NFW} = 10^8$, $c=20$

$N = 100,000$, $5\%$ binaries

$N = 28,000$, $40\%$ binaries
Models of Ultra-Faint Dwarfs?

Star cluster near centre \((R_{gc}=20\text{ pc})\), \(M_{NFW} = 10^8\), \(c=20\)

- \(N = 100,000\), 5\% binaries
- \(N = 28,000\), 40\% binaries

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Models of Ultra-Faint Dwarfs?

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\[ N = 100,000, \hspace{1em} 5\% \text{ binaries} \]

\[ N = 28,000, \hspace{1em} 40\% \text{ binaries} \]
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$N = 516$, $Nb = 608$
Models of Ultra-Faint Dwarfs?

Star cluster near centre ($R_{gc} = 20\,\text{pc}$), $M_{NFW} = 10^8$, $c=20$

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- $N = 28,000$, 40% binaries

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Models of Ultra-Faint Dwarfs?

Star cluster near centre ($R_{gc} = \cdots$)

$N = 100,000$, 5% binaries

\[ \sum (\text{stars/pc}^2) \]

$R_{gc} = 20\text{pc}$,

$M_{NFW} = 10^{8}$,

$c = 20$

Marin+08

Martin+08

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Models of Ultra-Faint Dwarfs?

$M_{300} \sim 0.7 \times 10^7 \, M_{\odot}$

$\sigma \sim 5 \, \text{km/s}$
Future ...

- complex tidal fields
- definition of tidal radius?

- explore initial $N, f_b, \text{density, sigma ...}$
  non-virial protoclusters, e.g. Hurley+Bekki08

- include gas?

- ...
N-body simulation background