

Predicting the limits of the ELT

Defensio

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Outline

1 Introduction

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2 Simulation

- Cluster
 - Time integration
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- Cone of vision
- Field stars

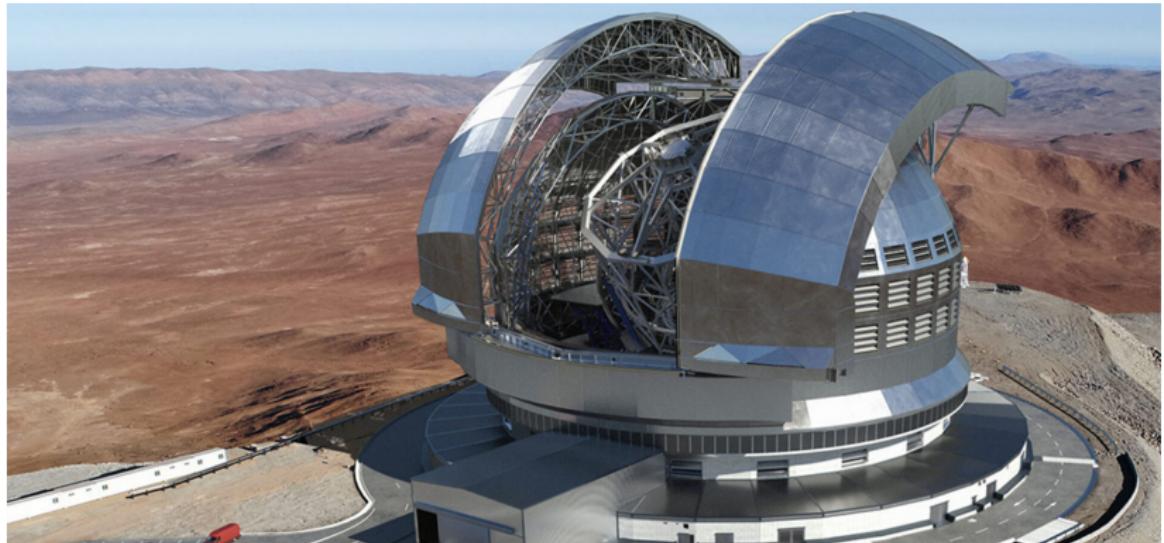
Goals

Primary objective

Estimate reliability limit for future IMF studies in the galactic centre using the ELT!

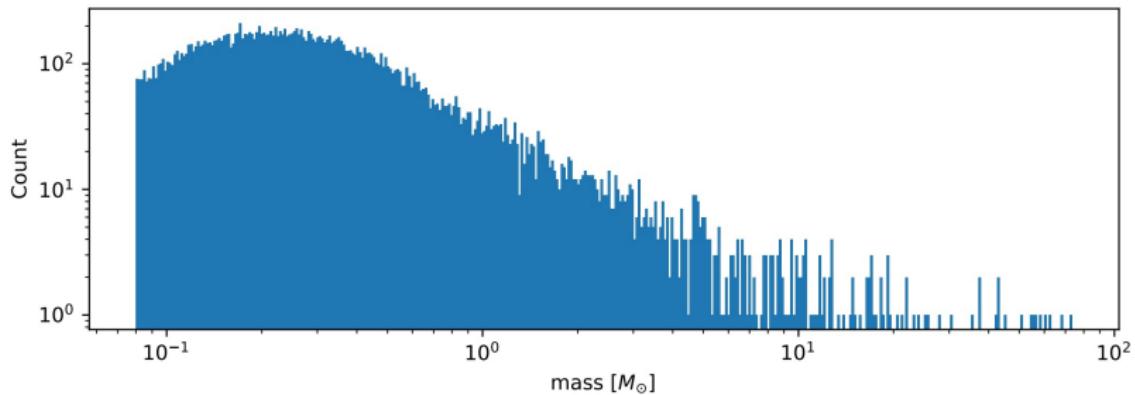
... what?

ELT

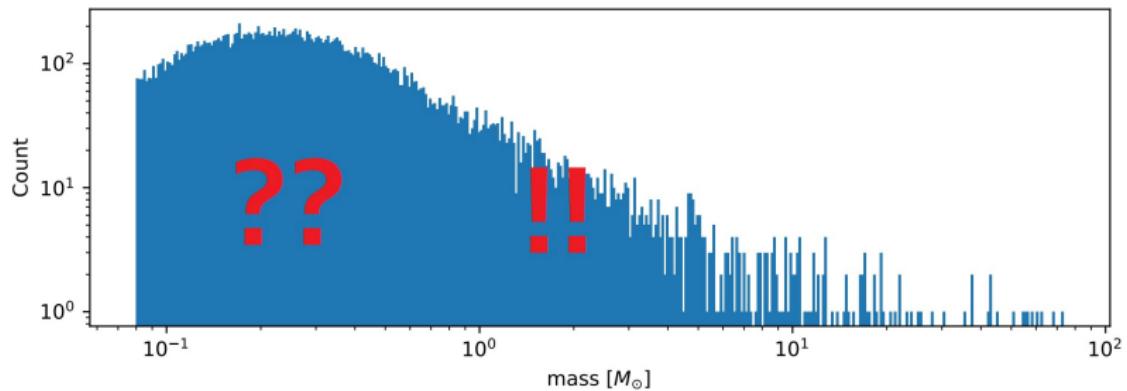


<https://cdn.eso.org/images/banner1920/telescope-dome-landing.jpg>

IMF



Reliability Limit



Motivation

- Universal IMF?
- estimate number of lower-mass stars
- understand star formation process
- N-body simulation with $N \gg 1$
- Clustering of time-dependent data

Action Plan

1. Simulate stars
2. Observe stars
3. Analyze
4. Measure performance

Parameters

using McLuster

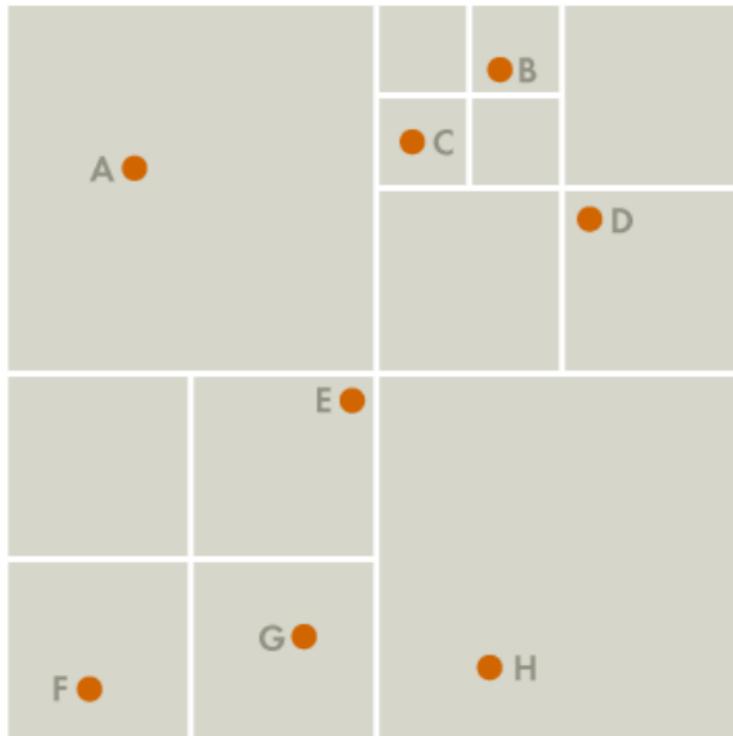
- Plummer density profile
- virial equilibrium
- Kroupa IMF $0.08 M_{\odot}$ to $100 M_{\odot}$
- Metallicity in range 0.5 - 2 solar
- No binaries
- N 1.3k - 40.4k

1. Issue with large N

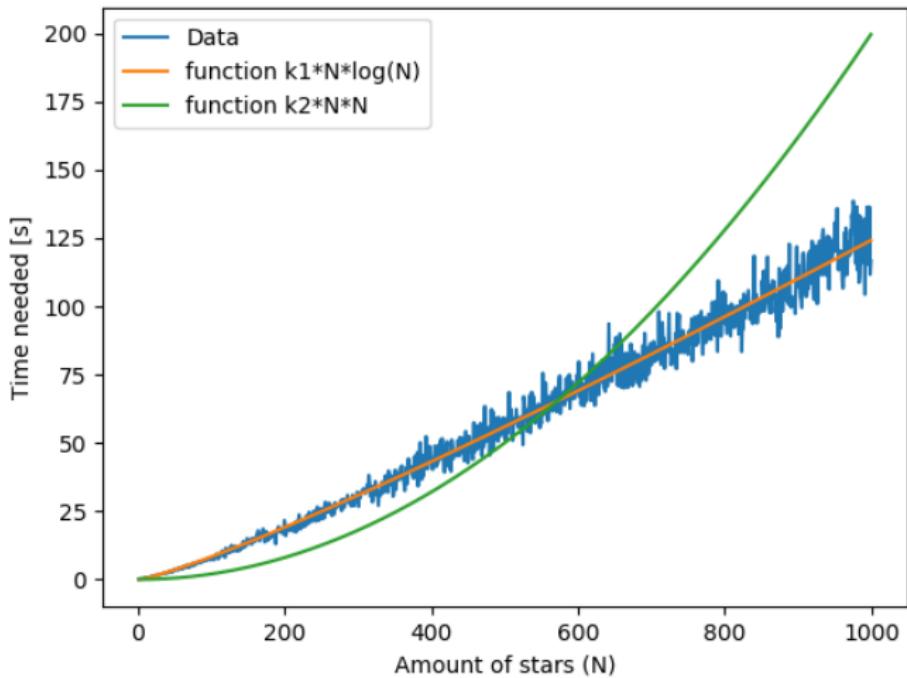
Direct summation $O(N^2)$

Barnes-Hut Algorithm $O(N \log(N))$

- approximate with macro particles
- $\frac{width}{distance} < \theta_{max}$

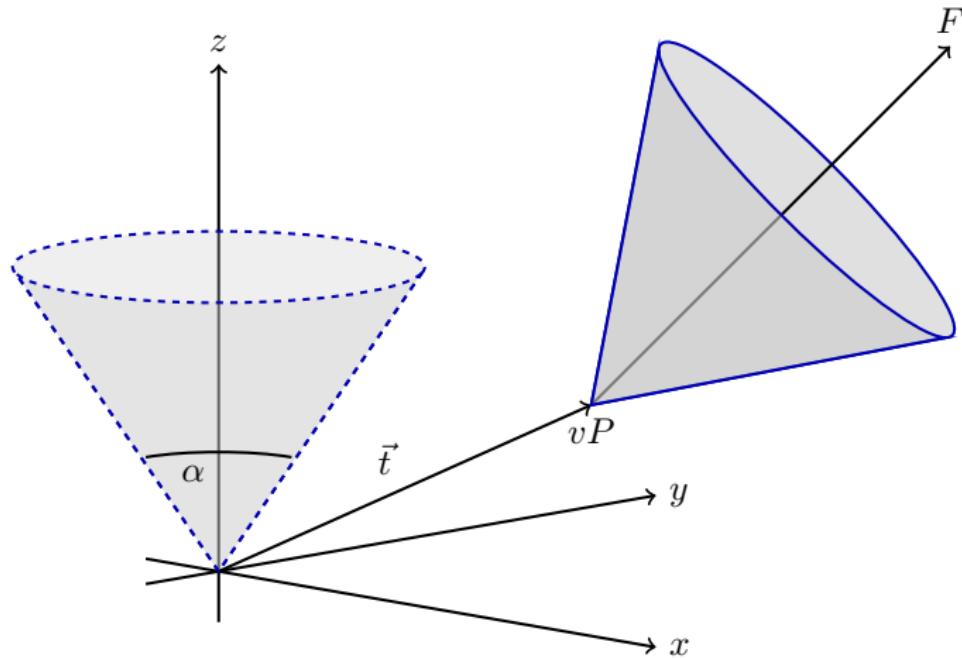


<http://arborjs.org/docs/img/example-space.png>



Multi-component axis-symmetric potential

- components
 - Black hole: Keplerian potential
 - Disk: Miyamoto Nagai potential
 - Bulge: Hernquist potential
 - Dark matter halo: Navarro–Frenk–White potential
- needed for
 - Force from analytic derivatives
 - Initial conditions for field stars



Initialize mass (1)

Total mass inside code

$$M = \int_{-R}^R \int_{-\sqrt{R^2 - x^2}}^{\sqrt{R^2 - x^2}} \int_{\frac{h}{R}r}^h \rho \left(\mathbf{T} \cdot \begin{pmatrix} x \\ y \\ z \end{pmatrix} \right) dz dy dx$$

R cone base radius

T transformation matrix

h cone height

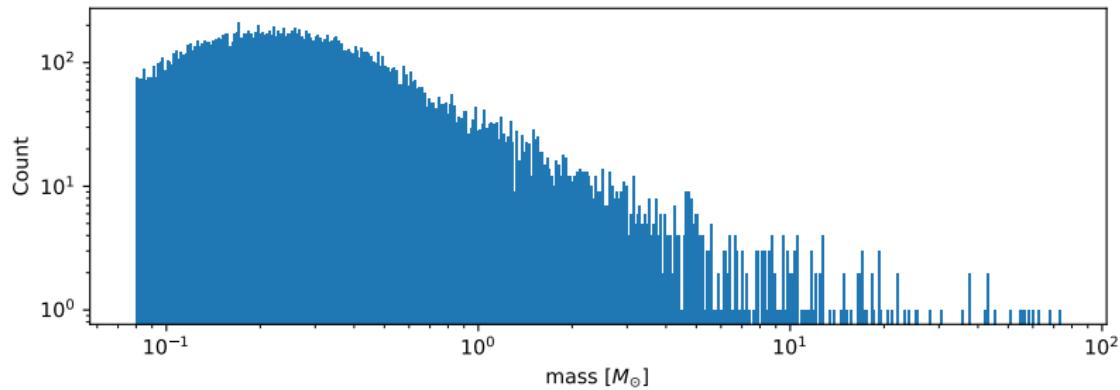
Integration

- GSL: GNU Scientific Library
- Gauss-Kronrod quadrature

Initialize mass (2)

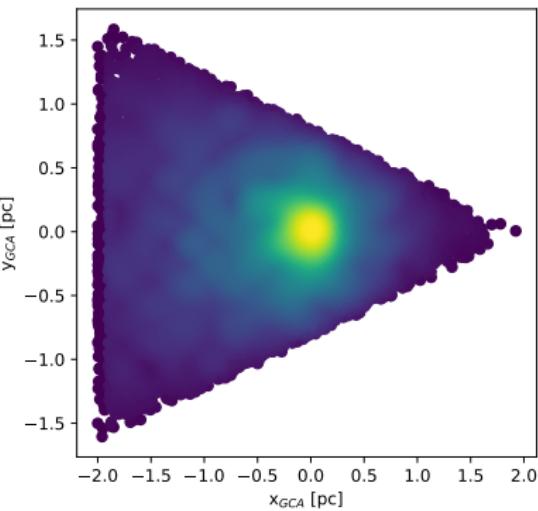
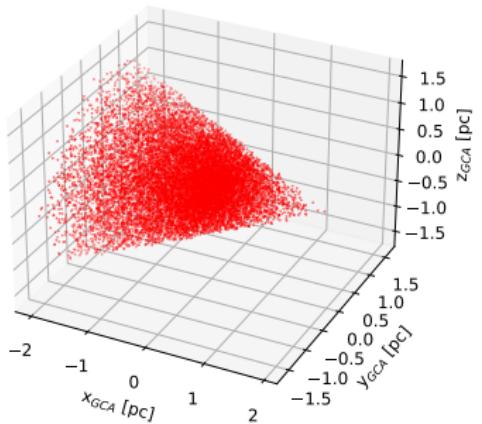
Sample mass functions

- rejection sampling
- inverse transformation sampling



Positions

1. uniform distribution
2. transformation
3. rejection sampling



Velocities

Solve Jeans equations

- Disk
 - Epicyclic Approximation
 - average & dispersion
 - Sampled from Gaussian distributions
- Bulge
 - $\sigma_r^2 = \frac{1}{\rho} \int_r^\infty \rho \frac{\partial \Phi}{\partial r} dr$
 - Lookup table
 - isotropic
 - limited by escape speed

