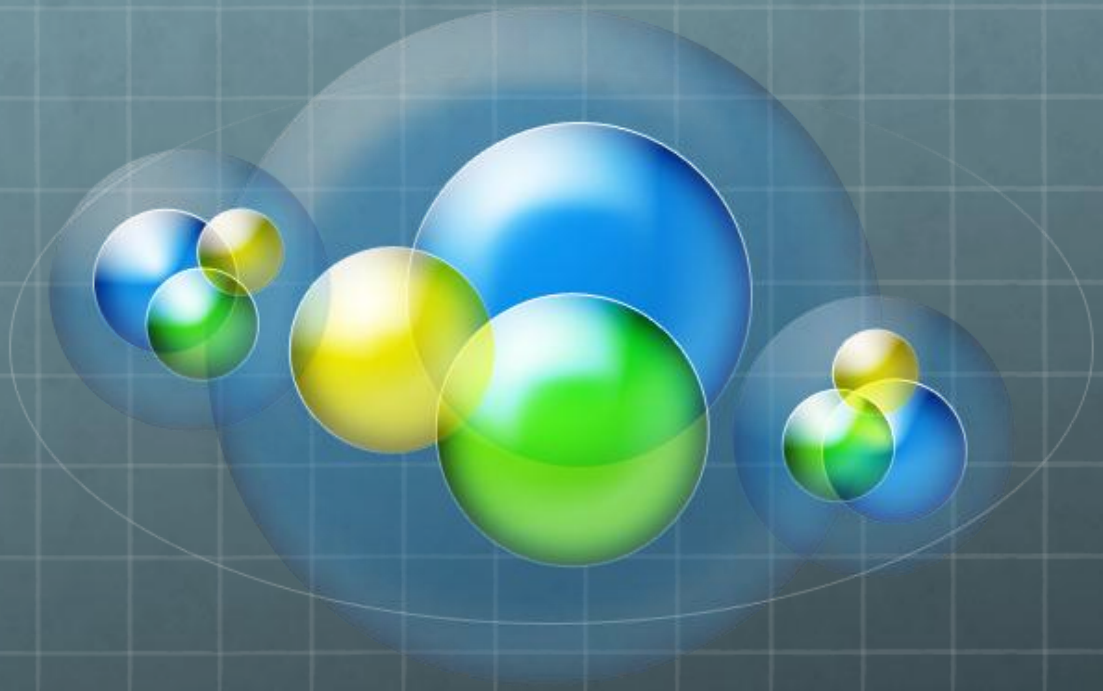
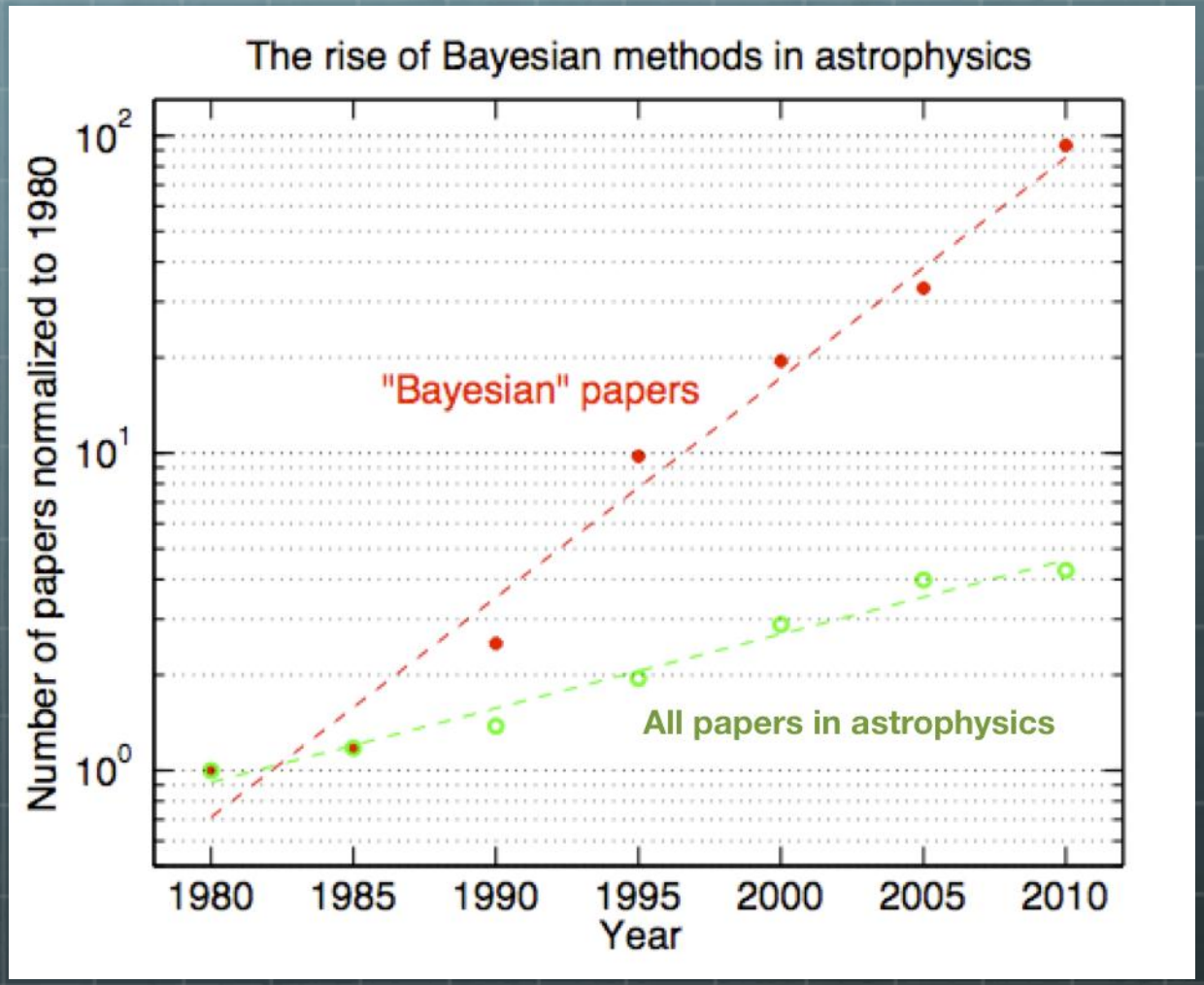
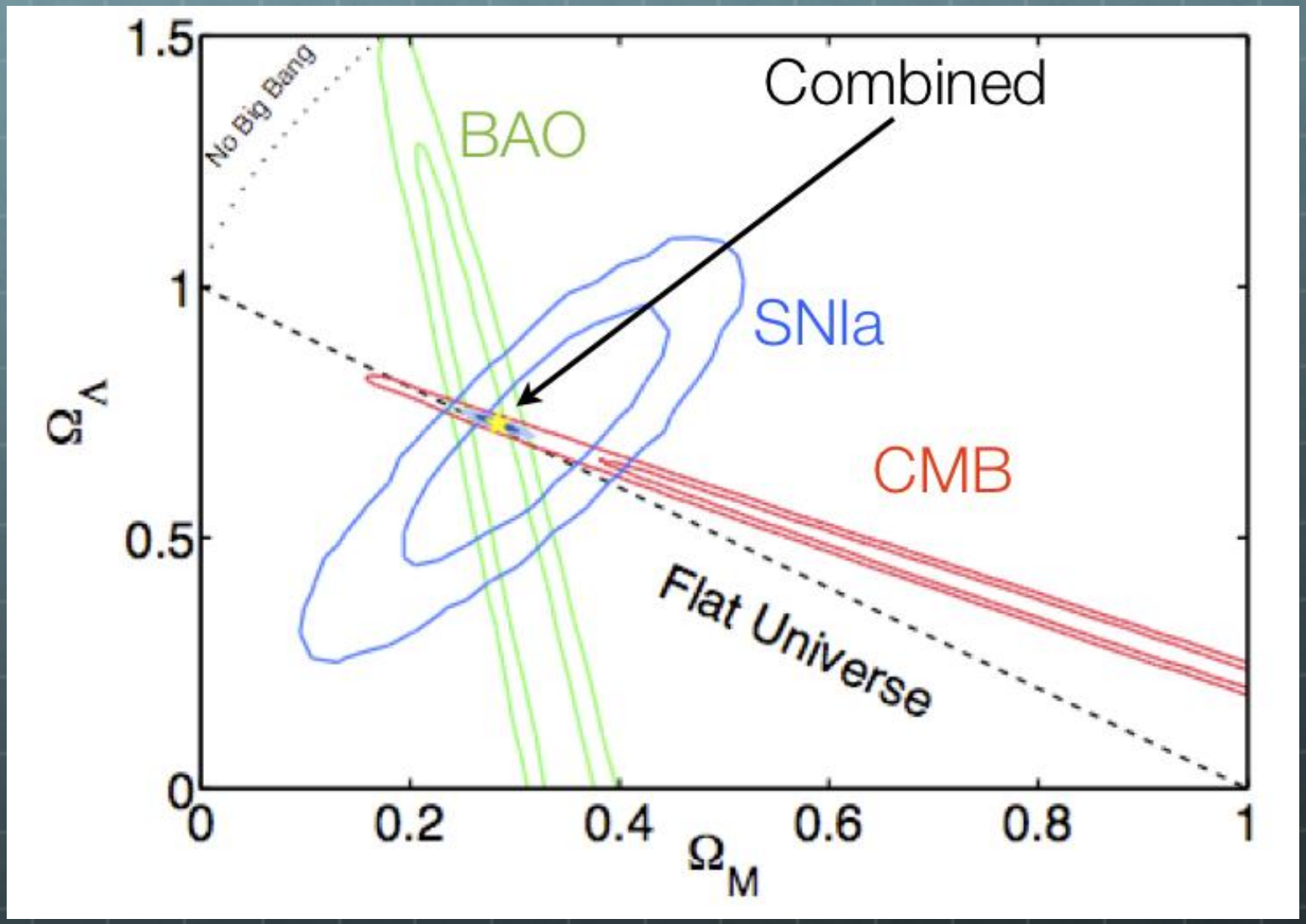


Astrostatistics

Tim Naylor – Head of Physics
Norman Lockyer Professor of Astrophysics

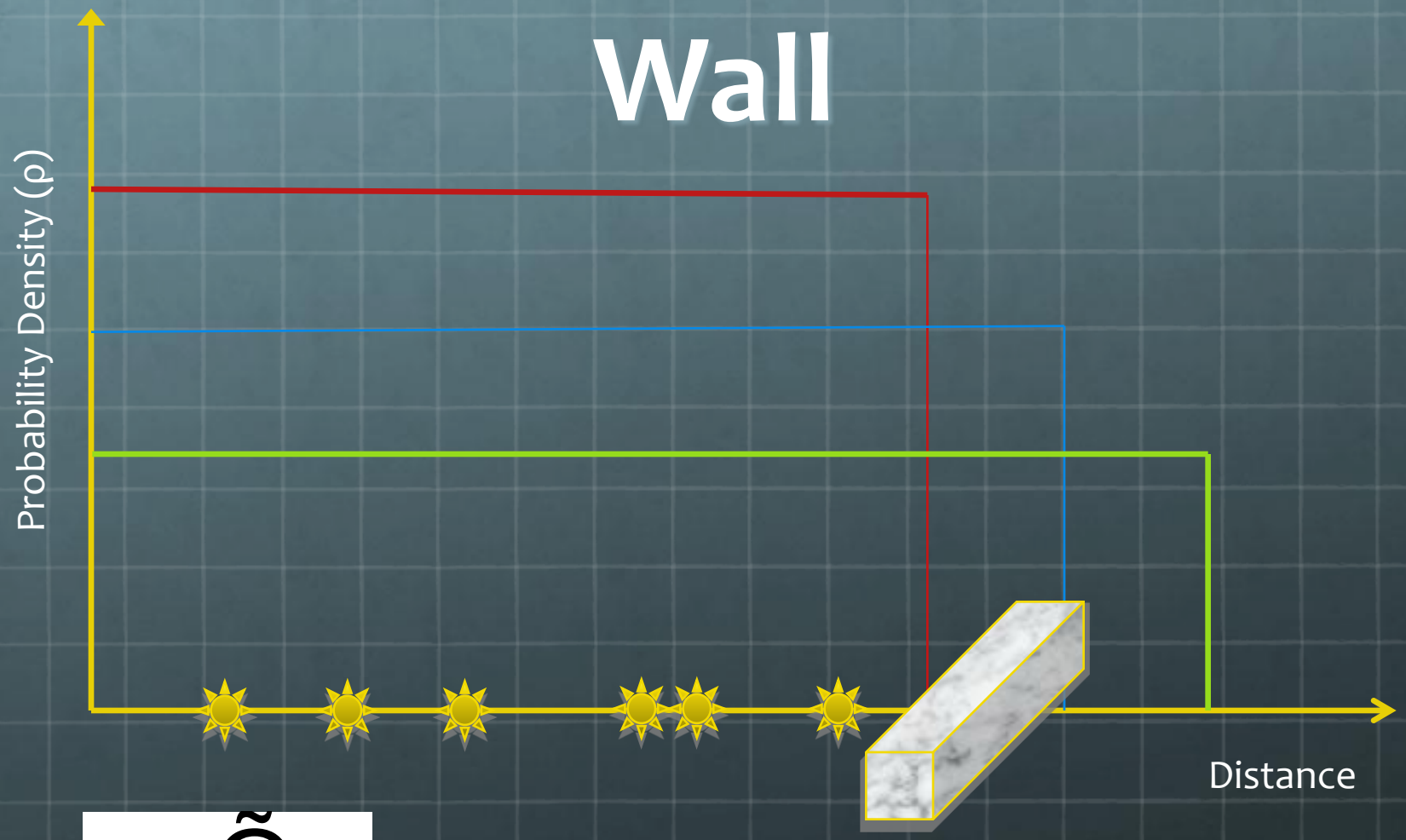


Trotta SCMA V



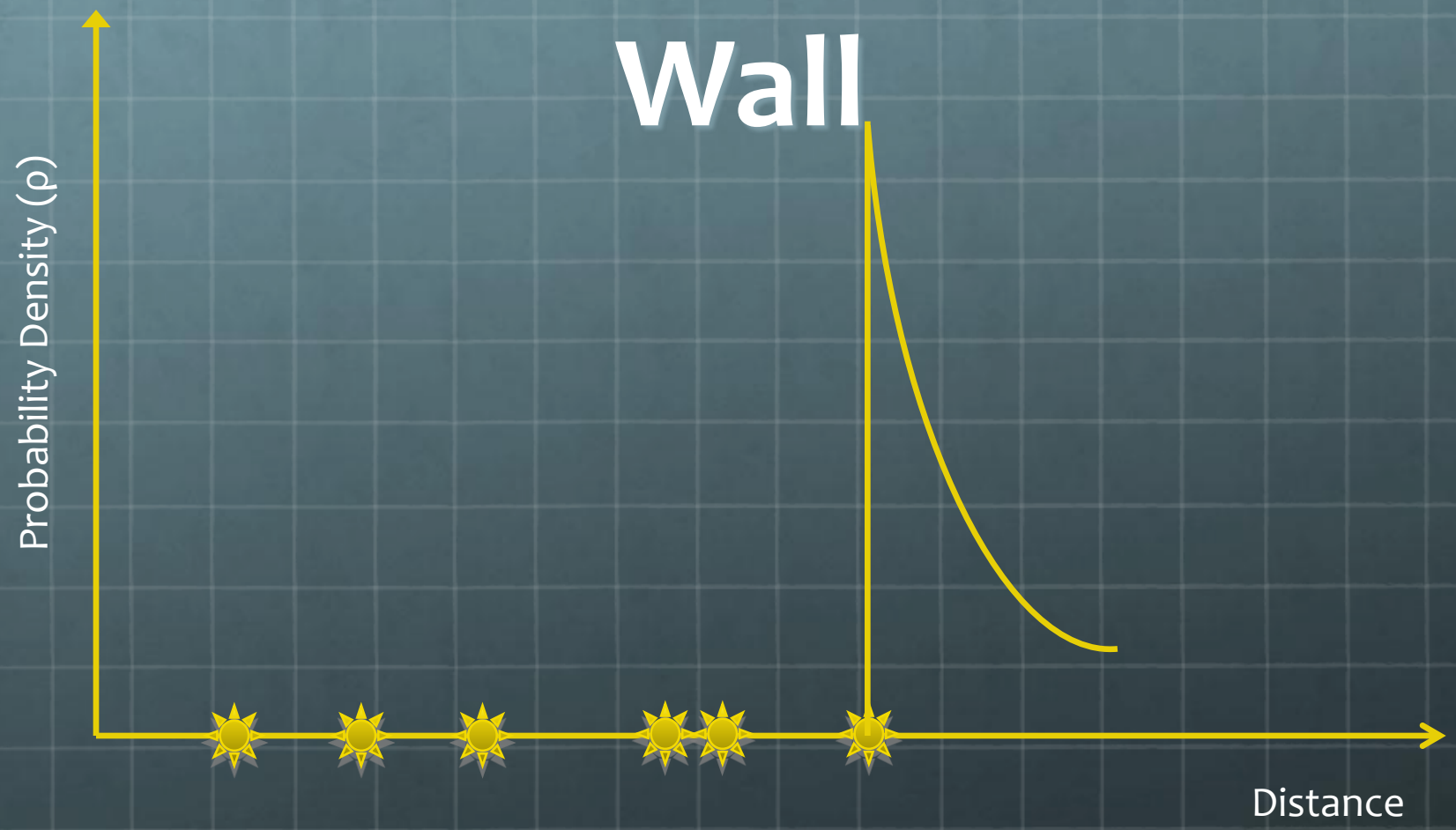
March et al via
Trotta SCMA V

The Wildebeest and the Wall



$$\mathcal{L} = \tilde{O}_{i=1,N} \, r_i$$

The Wildebeest and the Wall

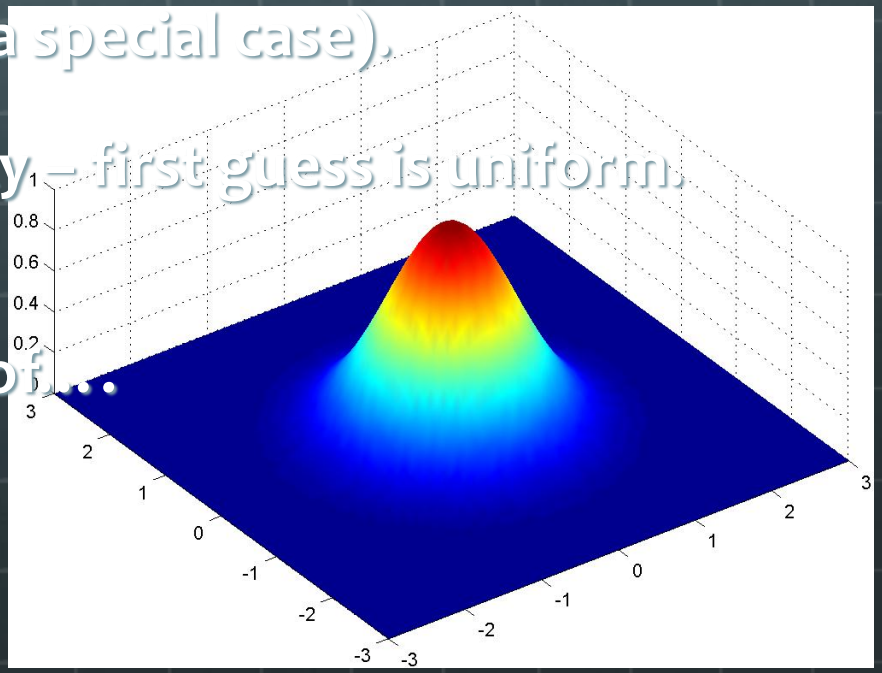


$$\mathcal{L} = \tilde{O} \, r_i$$

$$t^2 = -2 \sum_i \ln \int U_i(x - x_i) r(x) \, dx$$

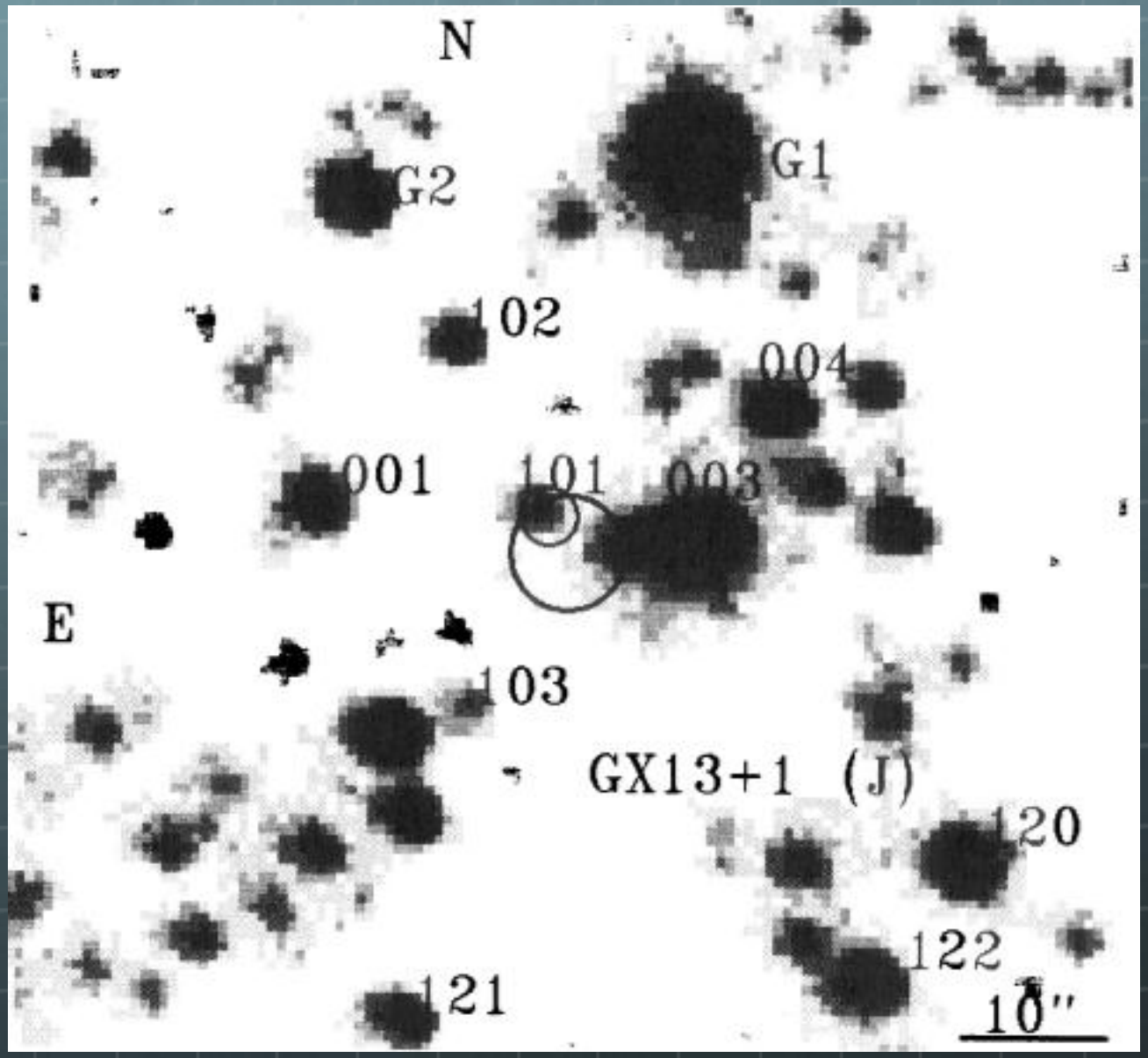
Uses

- Problems where you might have used cumulative distributions (e.g. Kolmogorov-Smirnov tests).
- Works well in higher dimensions.
- Deals with error bars (χ^2 is a special case).
- Positions of stars on the sky – first guess is uniform.
- Add an extra star whose position you are uncertain of…



A Catalogue Matching Problem

- You can test whether there is an “extra” star.
- For any single star the ratio of the uniform model to the Gaussian at that point tells you the probability it is THE counterpart.
- Two lists of sky co-ordinates for objects, one with large positional uncertainties – which objects should be paired together?



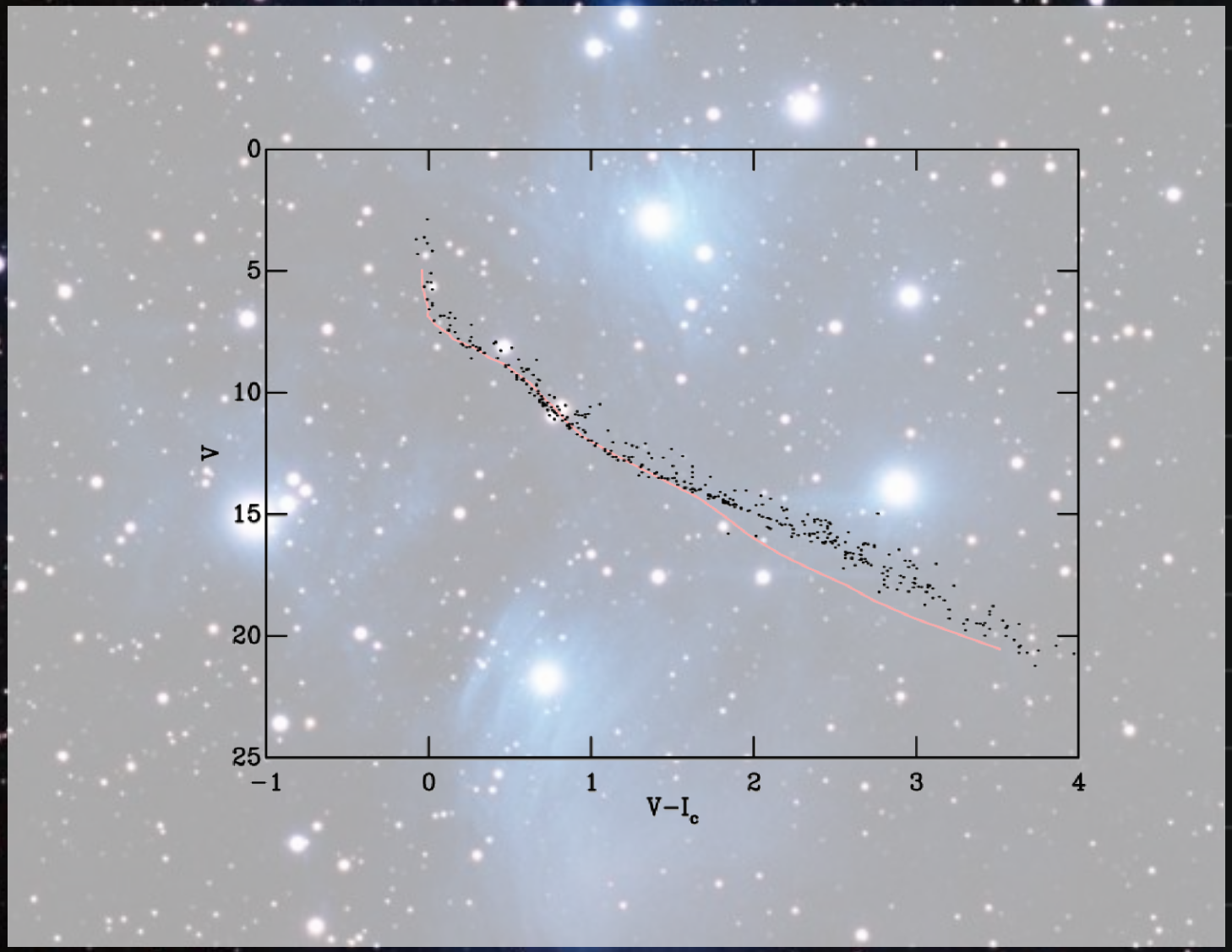
Naylor, Charles & Longmore (1991).

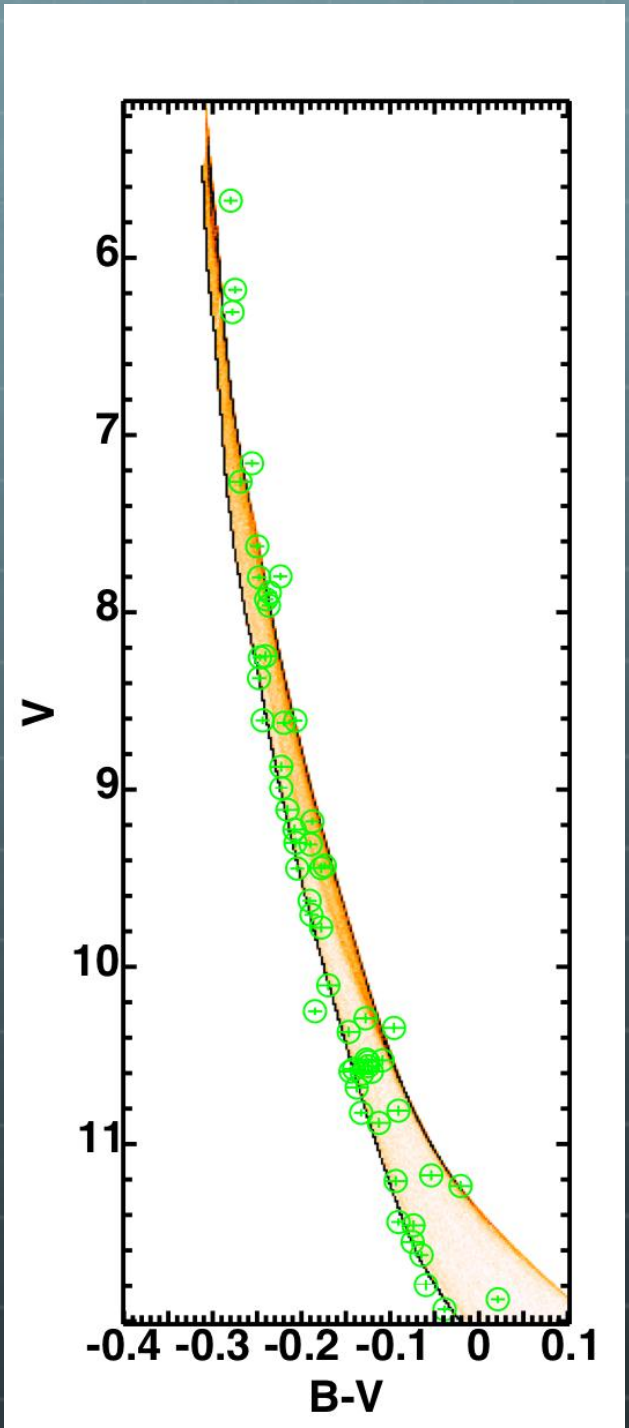
The Catalogue Matching Problem

- You can test whether there is an “extra” star.
- For any single star the ratio of the uniform model to the Gaussian at that point tells you the probability it is THE counterpart.
- Two lists of sky co-ordinates for objects, one with large positional uncertainties – which objects should be paired together?
- In general you cannot catalogue match without some prejudice about expected properties.

Colour-Magnitude Diagrams

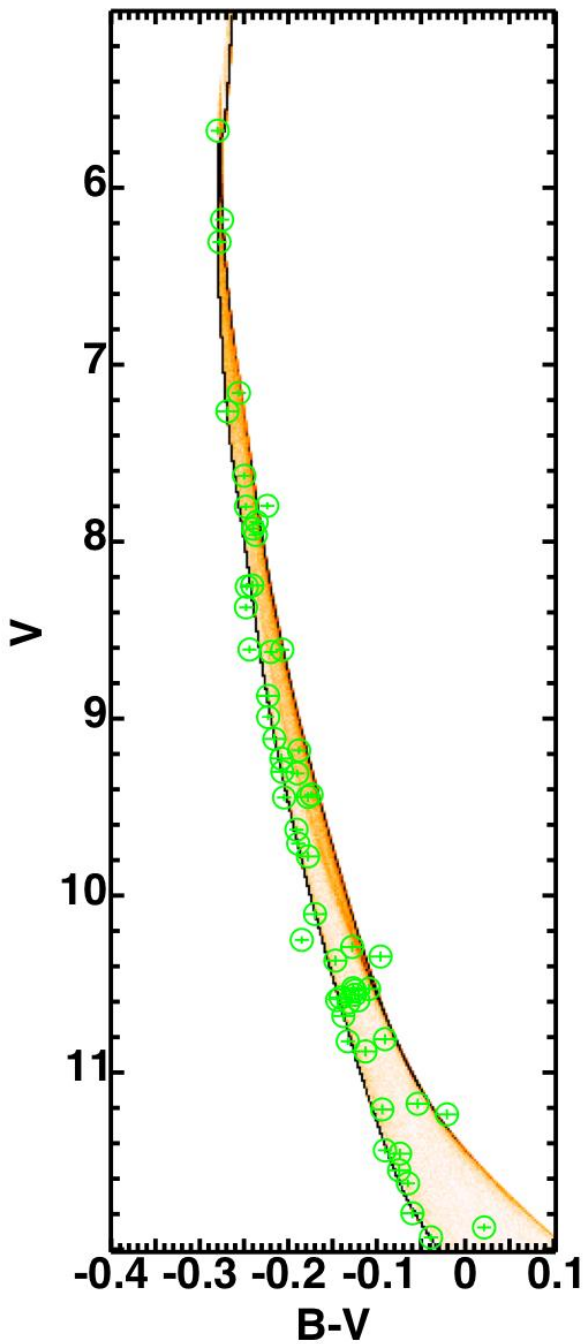
- The simplest measurement of a star is its flux integrated over a given wavelength range (the log of which is its magnitude).
- Next is the ratio between flux in one band and another (the log of which is its colour).
- Pick a group of stars at the same distance and of the same age and you get a colour-magnitude diagram.





Nuclear Ages

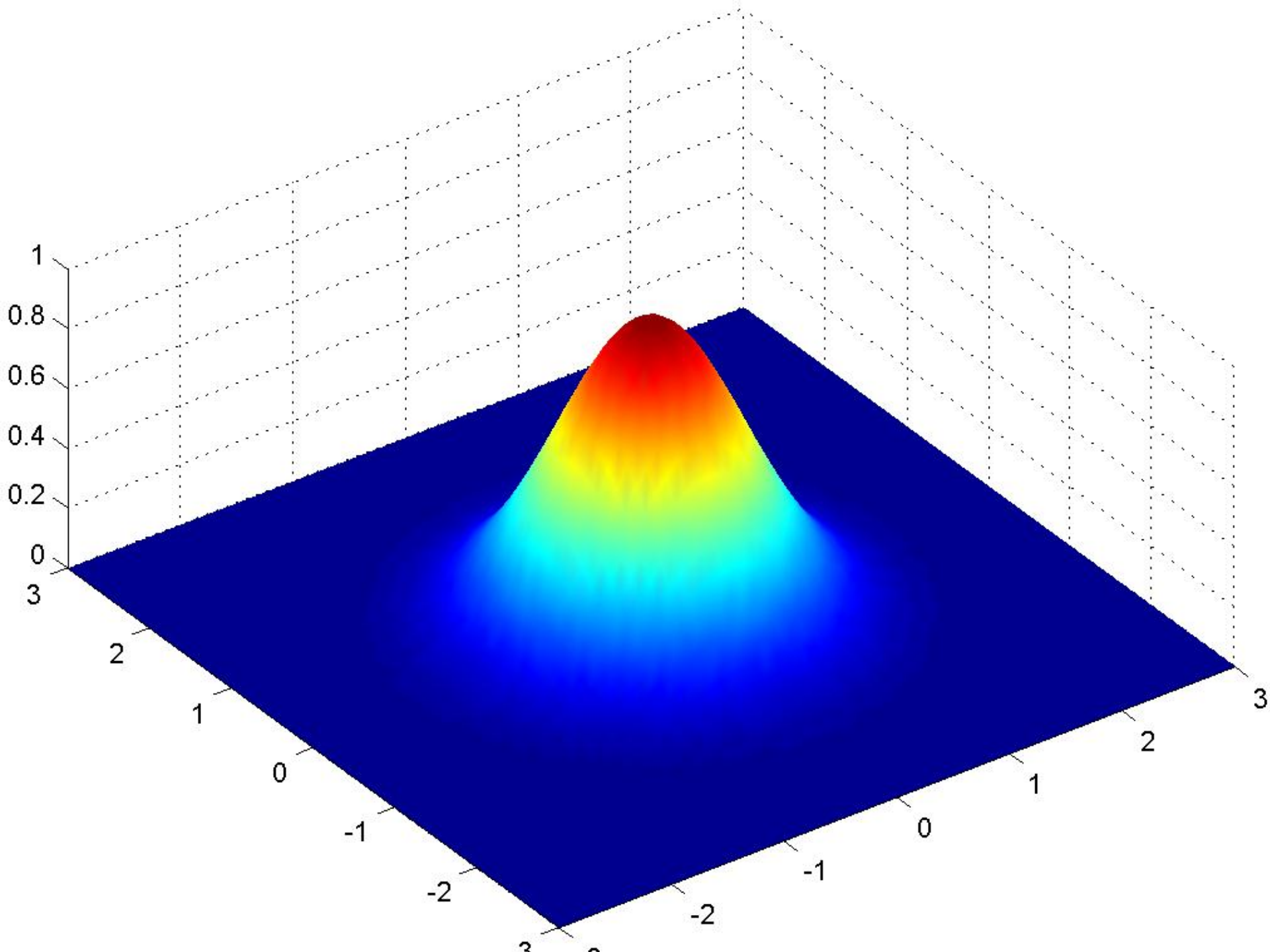
NGC 6530
0.25 Myr (Geneva-Bessell)
$Pr(\tau^2)=0.03$



Nuclear Ages

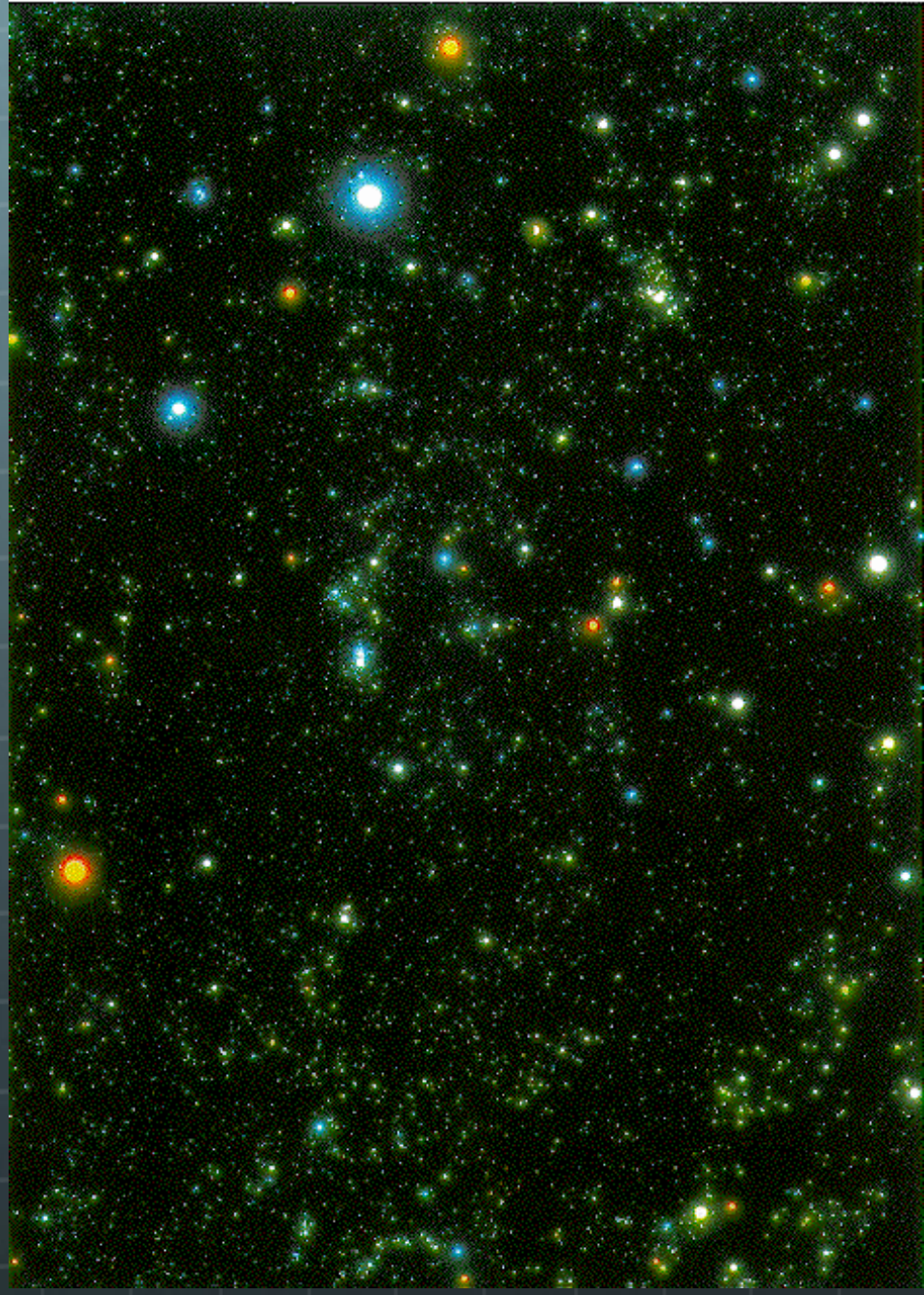
NGC 6530
5.50 Myr (Geneva-Bessell)
$Pr(\tau^2)=0.67$

Courtesy NASA/JPL-Caltech.

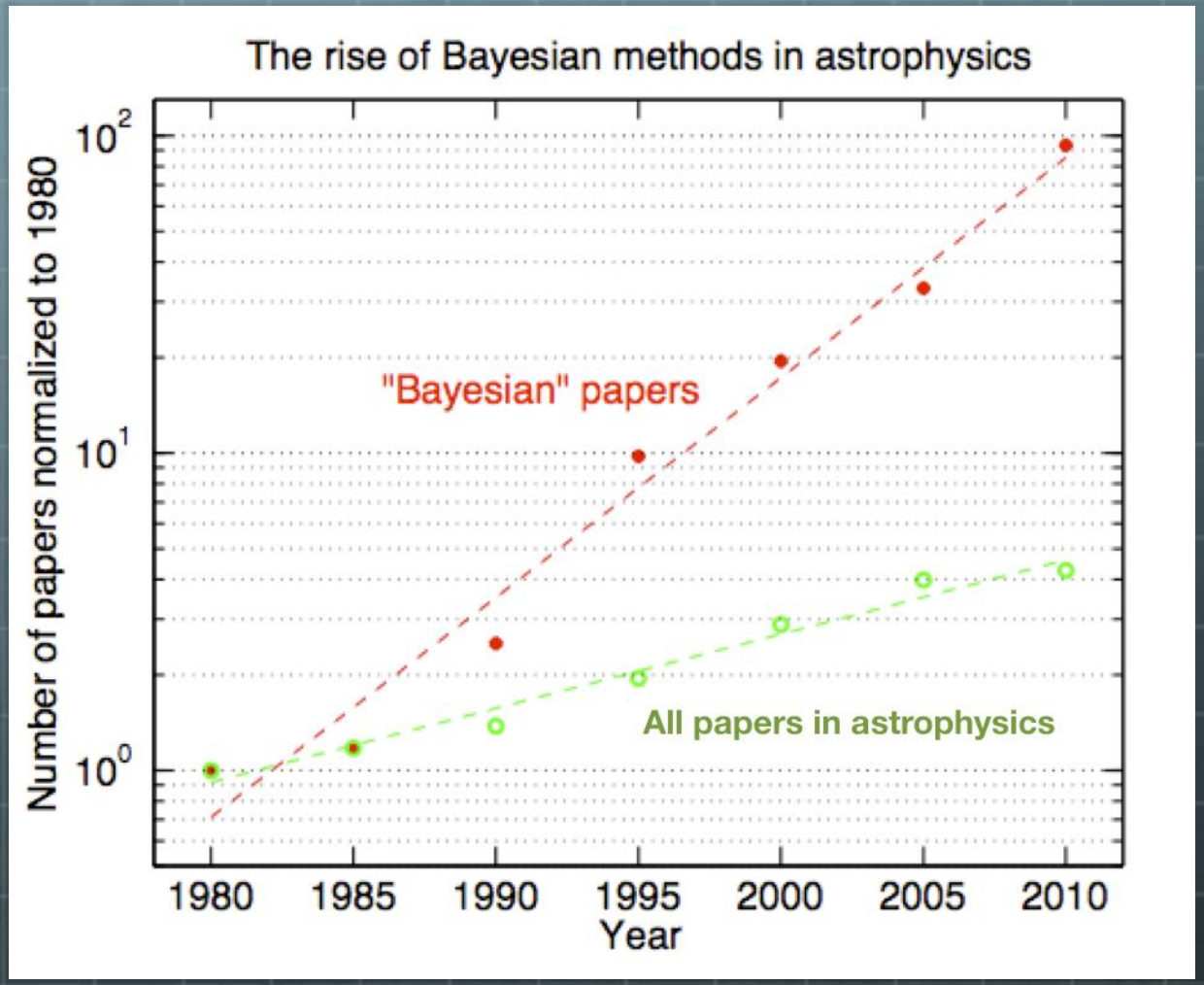

1
0.8
0.6
0.4
0.2
0
3
2
1
0
-1
-2
3
2
1
0
-1
-2
3

“There has not been a single date in the history of the law of gravitation when a modern significance test would not have rejected all laws and left us with no law.”

Harold Jeffries, “The theory of probability”, 1939



Leicester X-ray group



Trotta SCMA V