Astronomical Surveys: From Electrons to Science

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Princeton University

Yale, 2nd October, 2009

How To Analyze Astronomical Data

Inside the Sausage Machine

Example: Finding $z \sim 6$ Quasars

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With Xiaohui Fan and Michael Strauss and Željko Ivezić (and ...)

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How does a photometric survey find Quasars?

Colour Selection of Quasars

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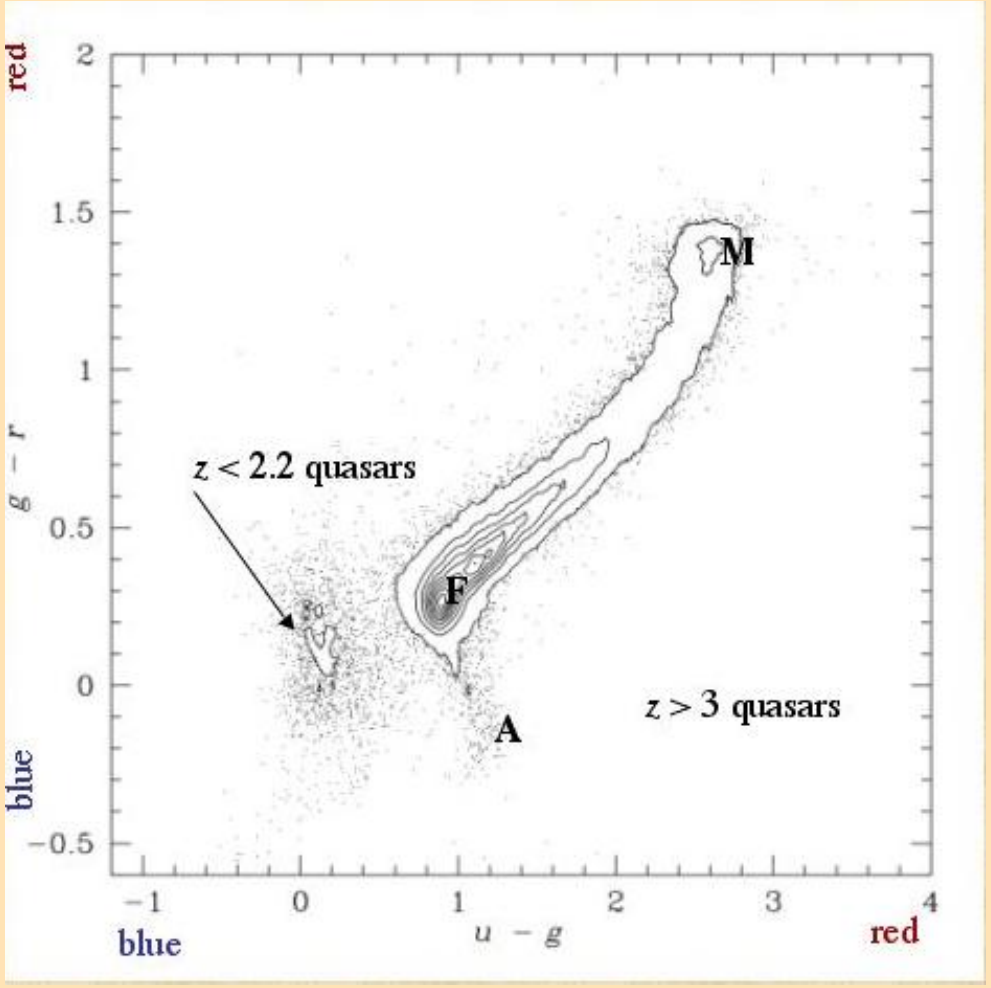

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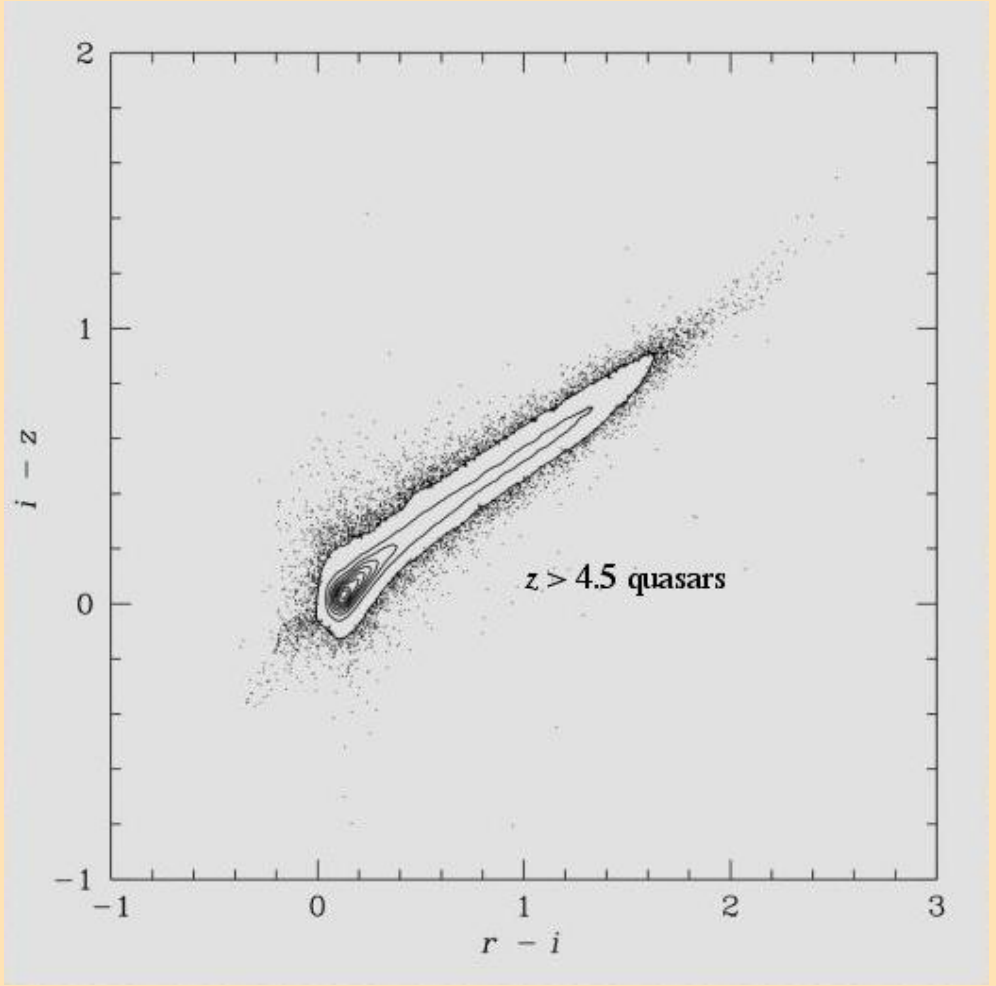
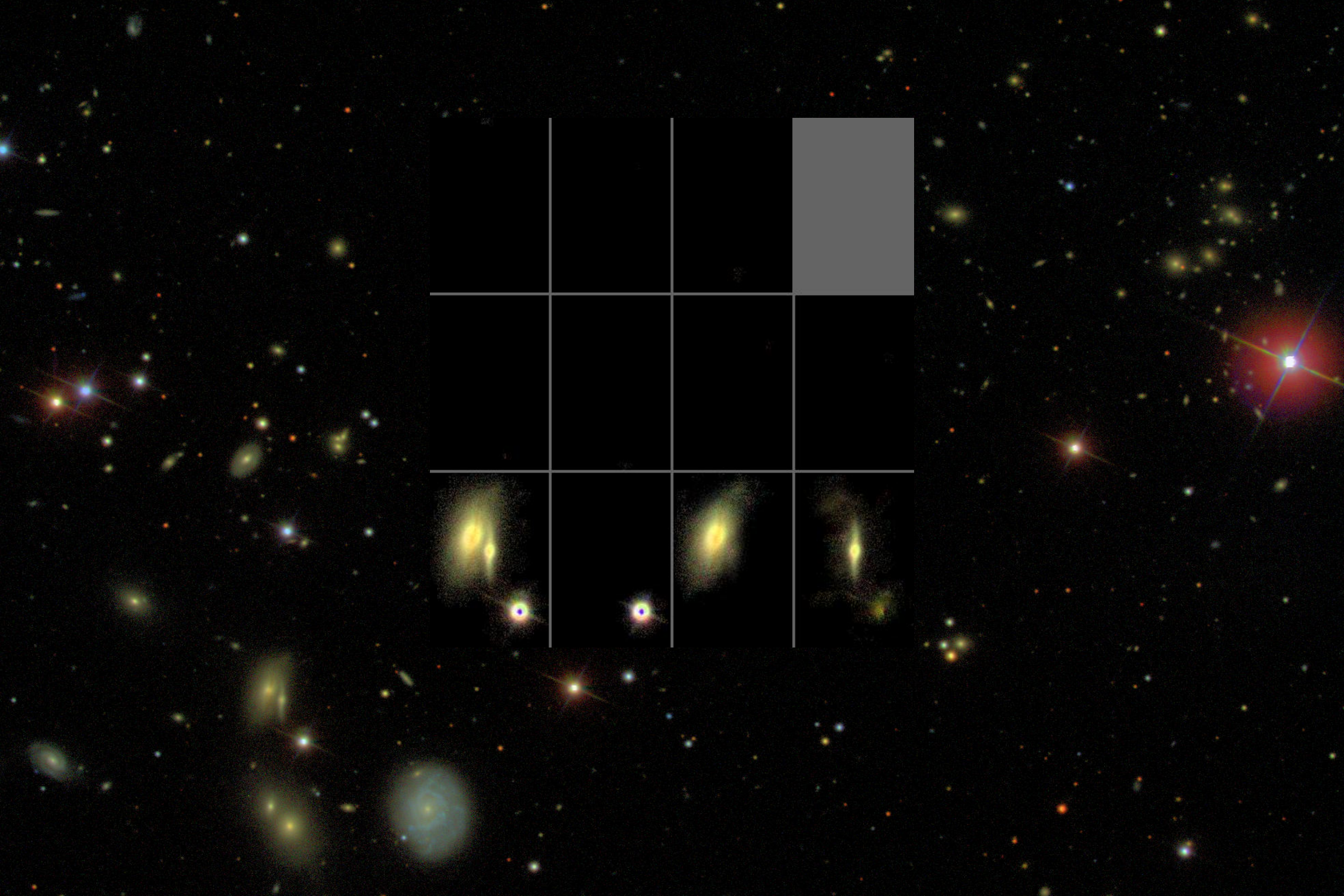
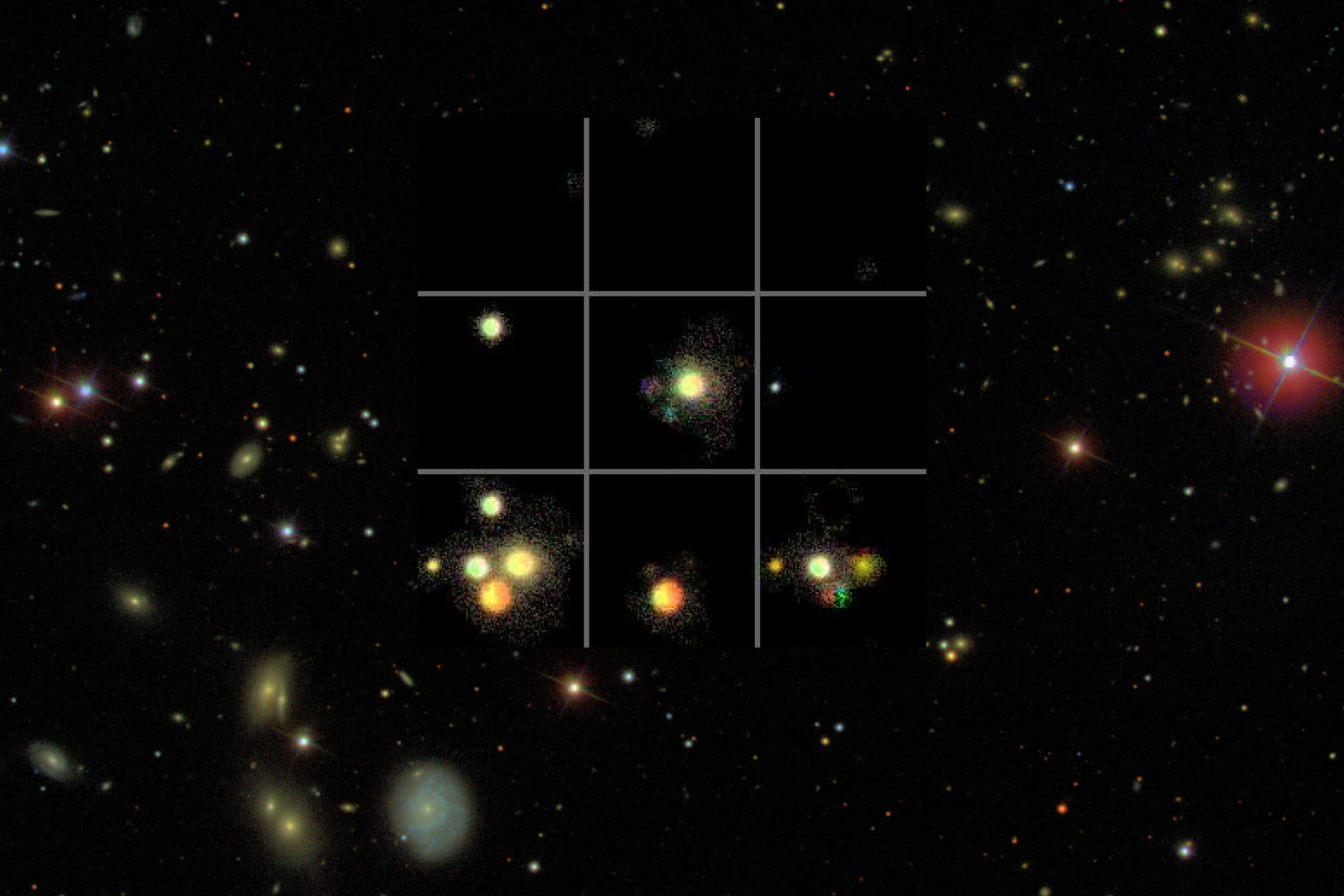
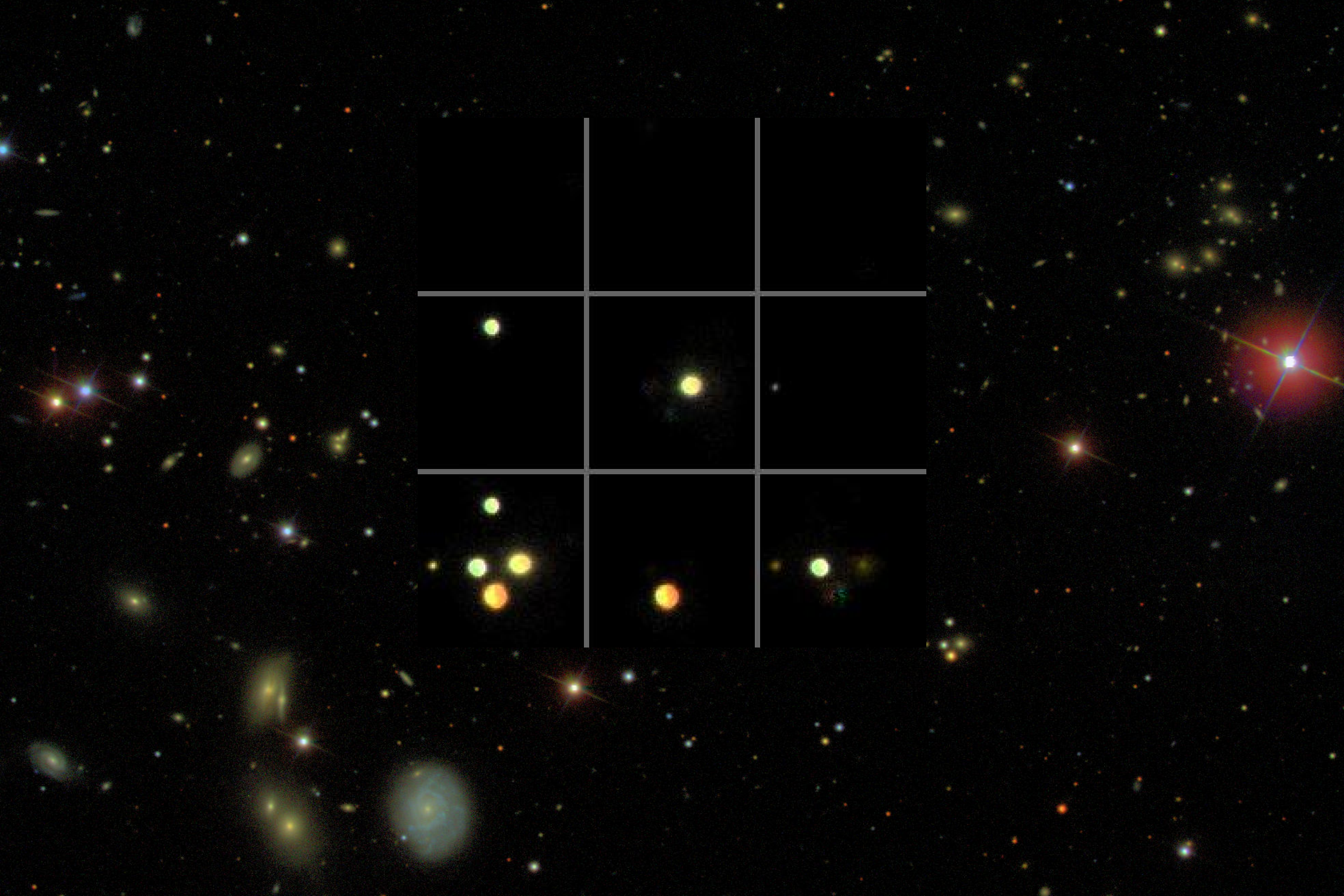


Why isn't this Easy?

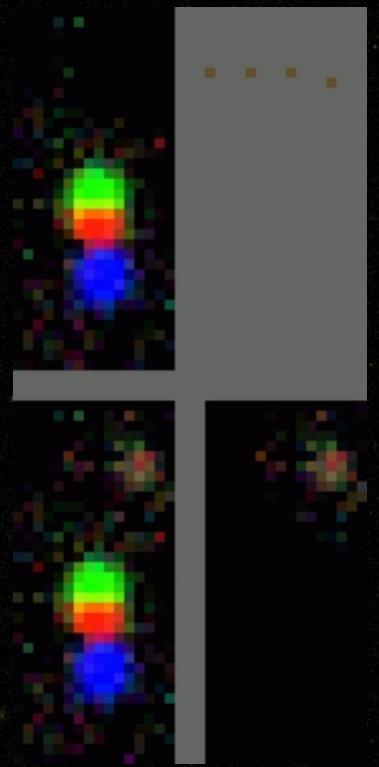

Objects Are Blended

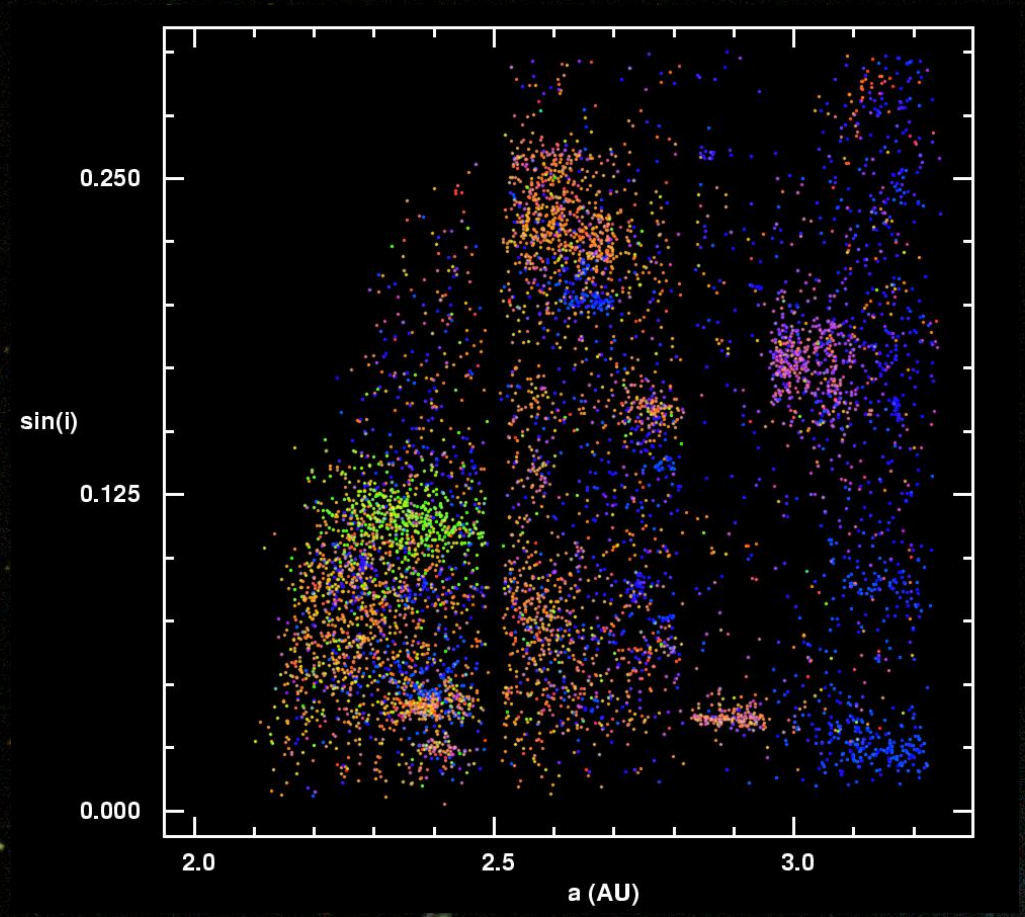






Objects Move





The semi-major axis v. (proper) inclination of a sample of known asteroids detected by SDSS

The PSF can be Complicated

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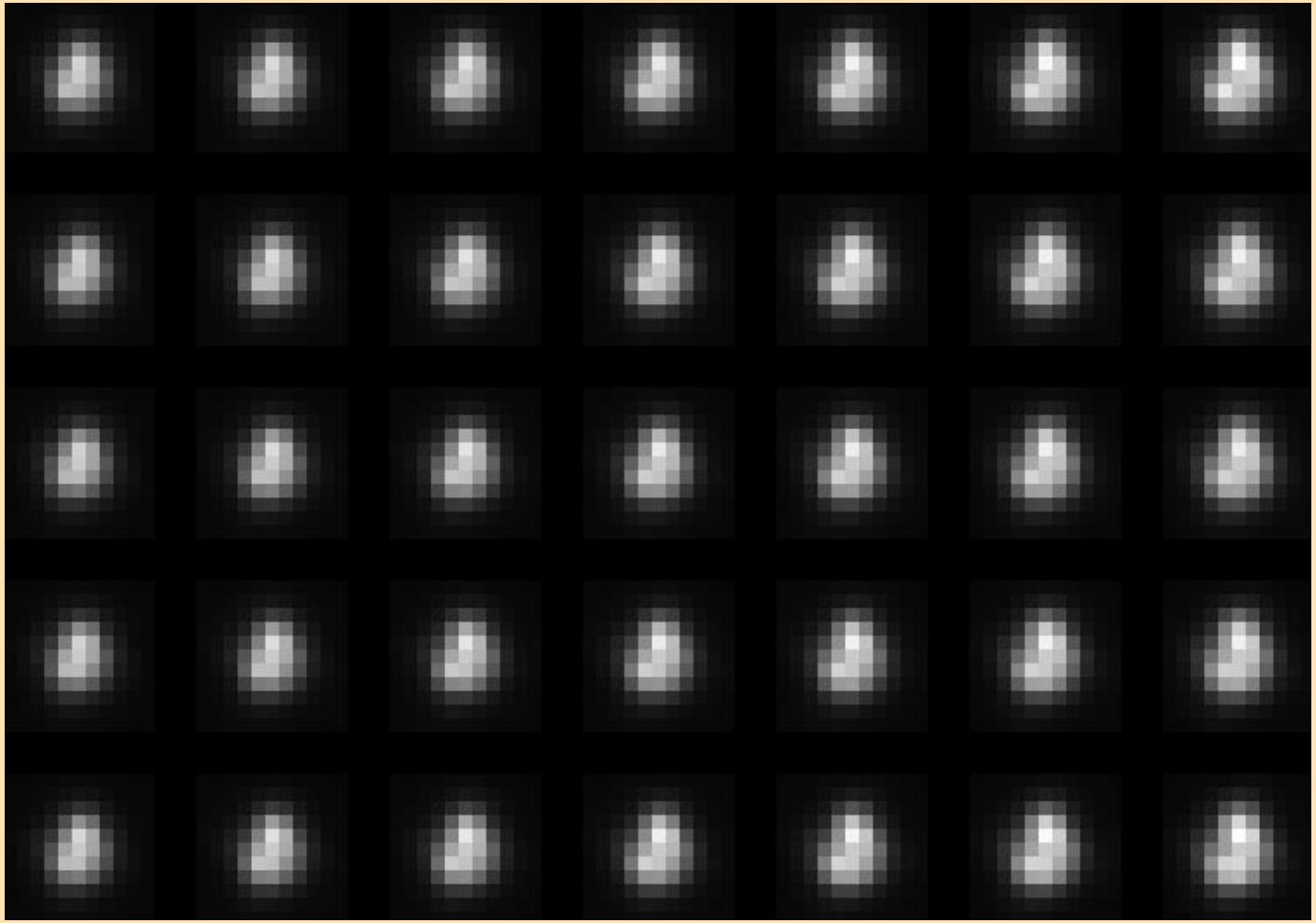

The PSF can be Complicated

Two solutions:

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- Normalise the seeing to some canonical form and value (cf. A&L image subtraction)
  - Involves some measure of deconvolution (or loss of S/N)
  - Slower, more complex code

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Two solutions:

- Normalise the seeing to some canonical form and value (cf. A&L image subtraction)
  - Involves some measure of deconvolution (or loss of S/N)
  - Slower, more complex code
- Estimate the seeing at the position of each object
  - Fast; a simple linear reconstruction at position of each object
  - The seeing is still variable across the frame

We chose the latter:

- KL decompose the bright stars in the frame, giving a number of basis functions (typically 3 or 4):

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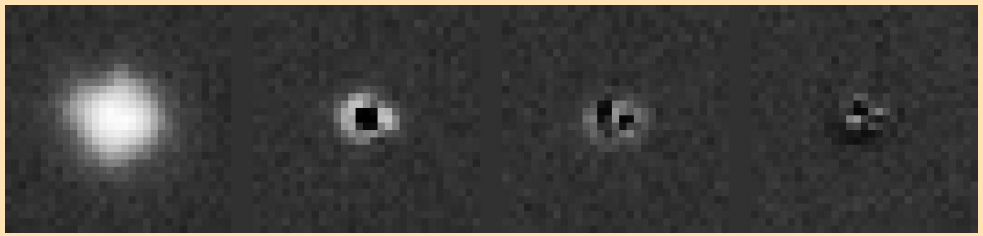

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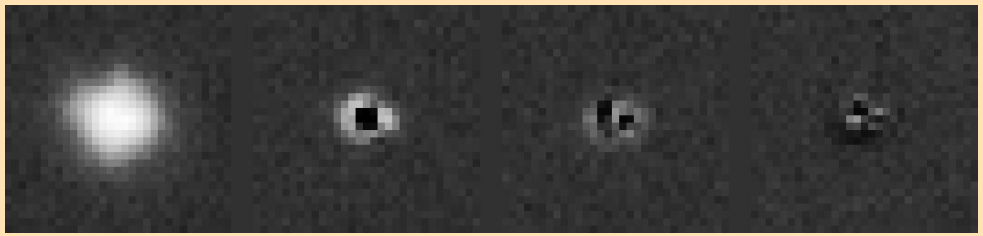


- Write the $A^{(\alpha)}$ as low-order polynomials in x, y:

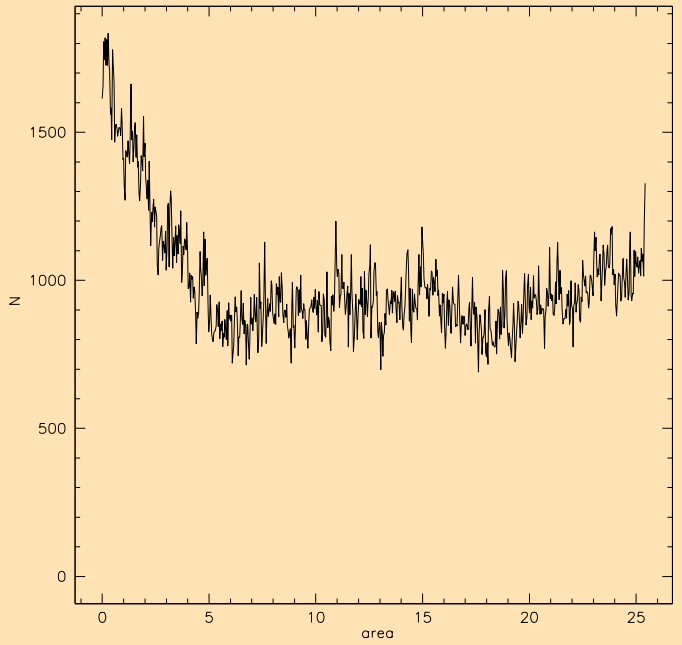
$$P_{ij}(x,y) = \sum_{\alpha=0}^{n-1} \sum_{r=0}^{n_r-1} \sum_{s=0}^{n_s-1} a_j^{(\alpha)} x^r y^s K_{ij}^{(\alpha)}$$

If you combine the last three points:

- blending
- moving
- variable seeing

it is not obvious how to build a catalogue out of a set of observations.

Not all Objects are Point Sources



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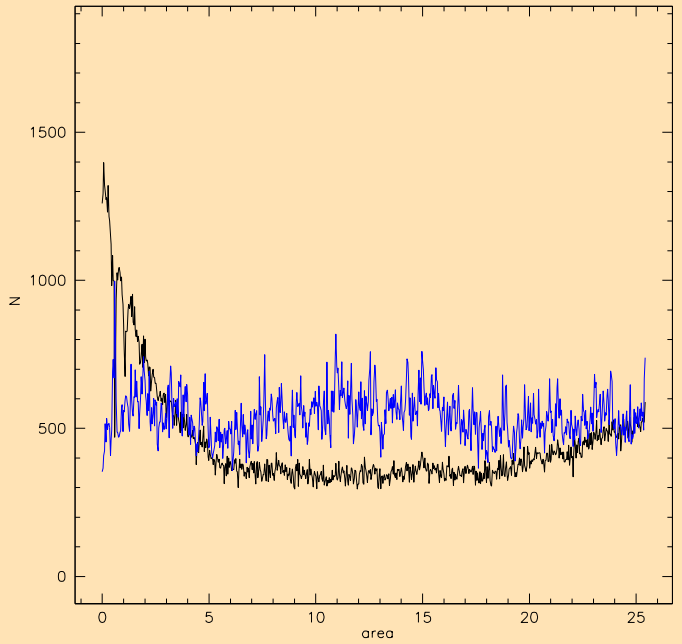

Stars and Galaxies

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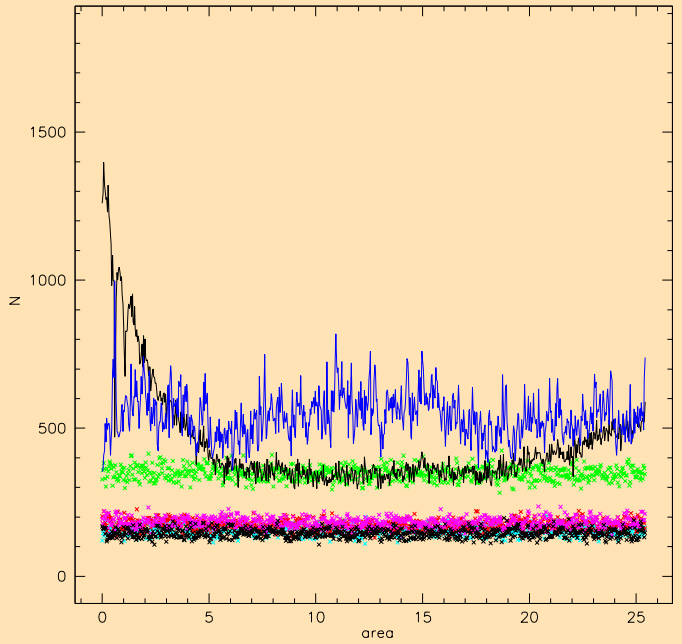

Stars and Galaxies and Cosmic Rays

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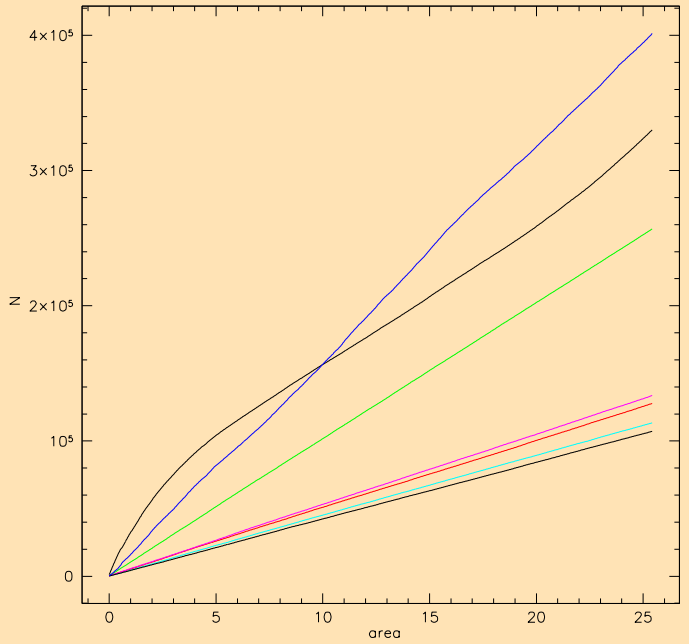
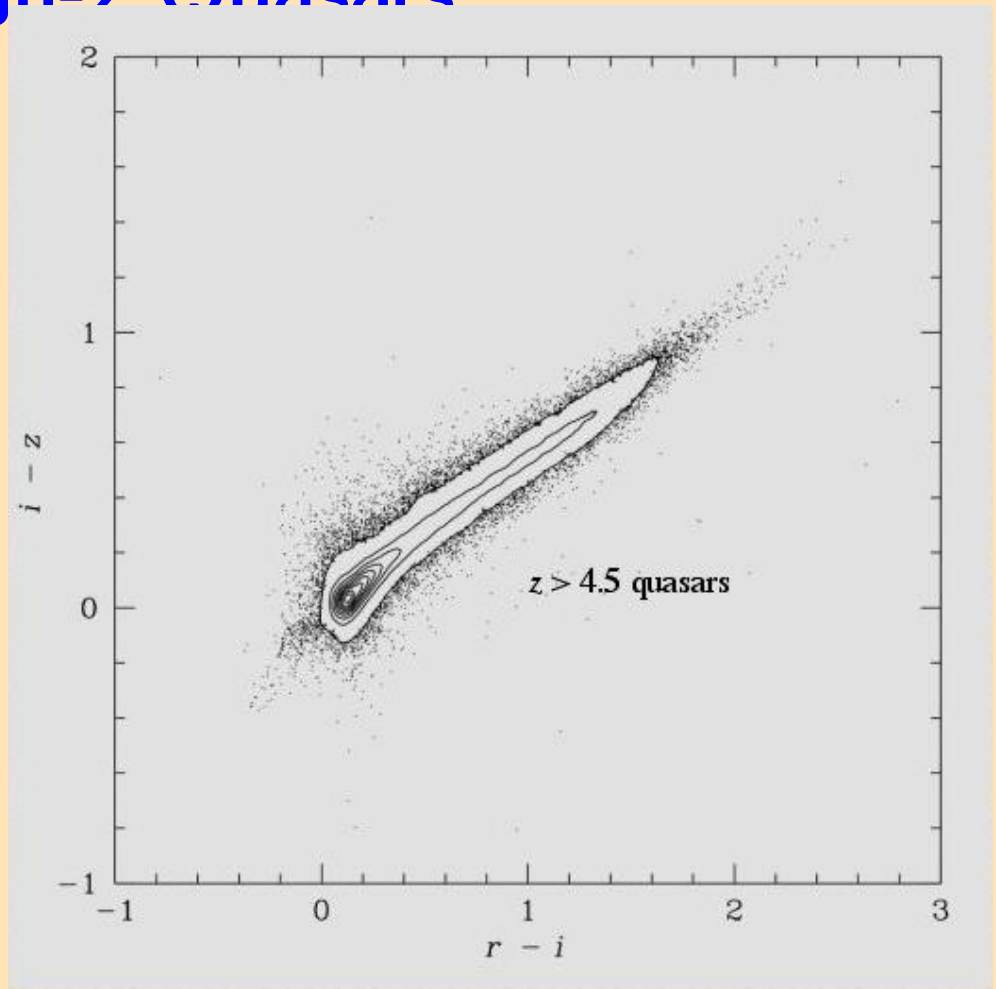
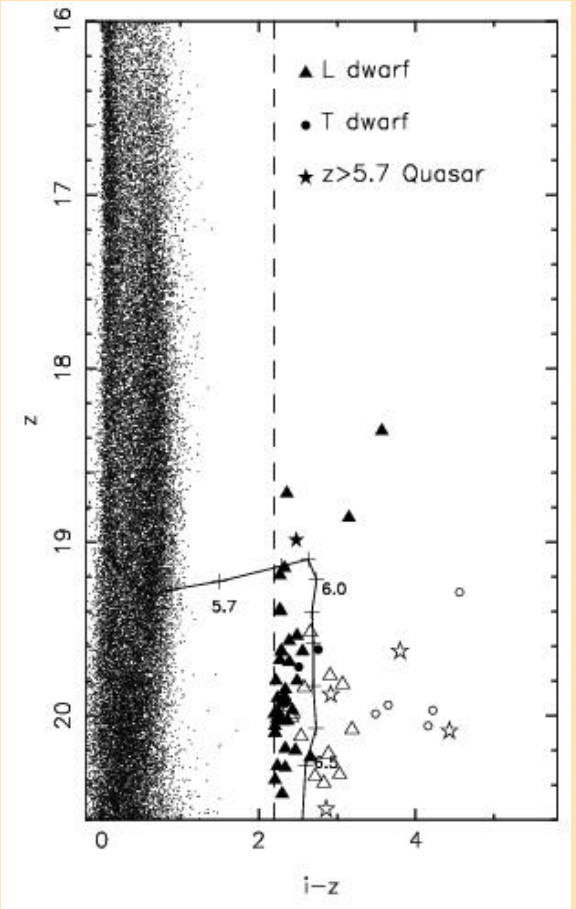


Stars and Galaxies and Cosmic Rays (cumulative)

High-z Quasars



High-z Quasars are not very Bright



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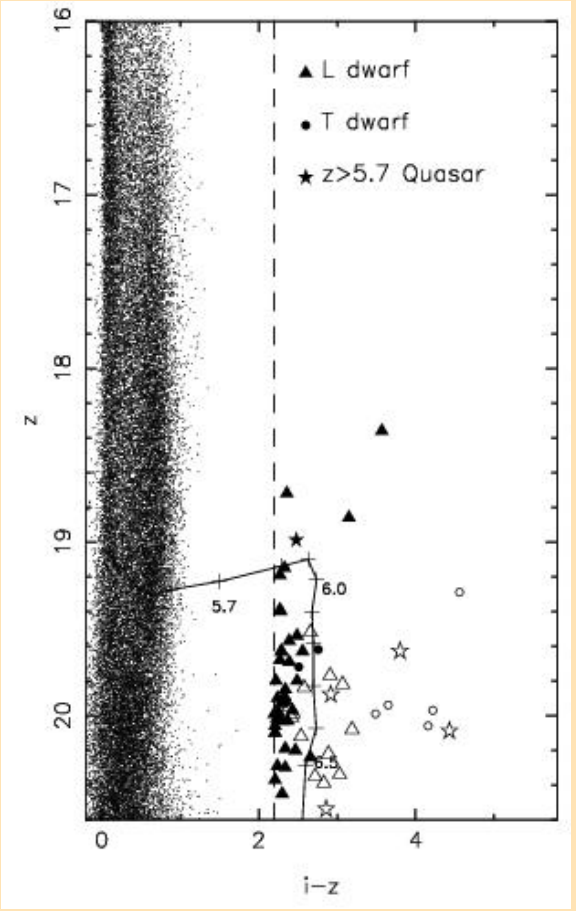

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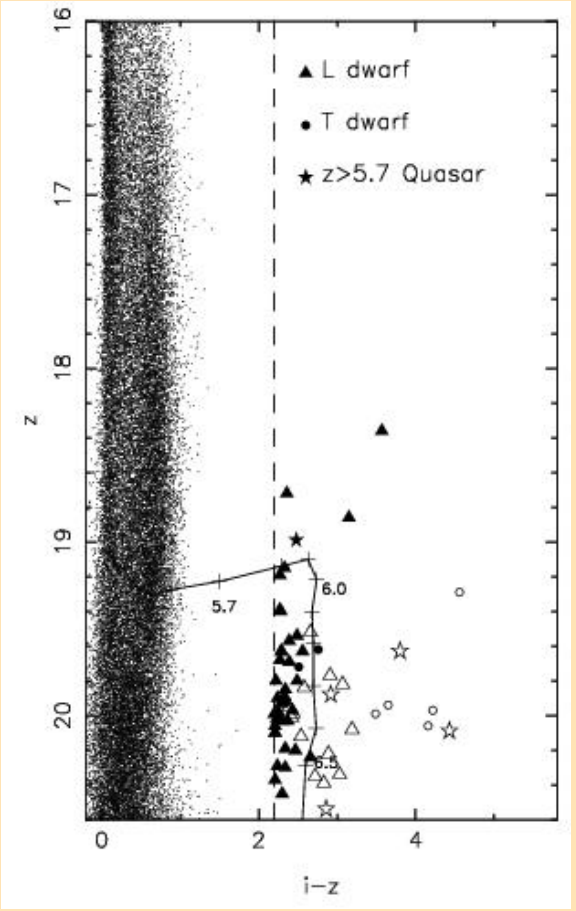

The small dots are 10^5 stars (from $\sim 10\text{deg}^2$ of sky)
The quasars (and L/T stars) are from $\sim 2000\text{deg}^2$

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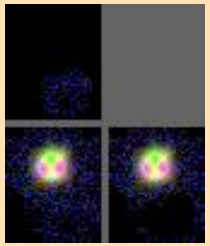

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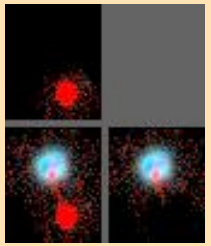

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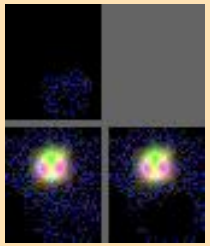

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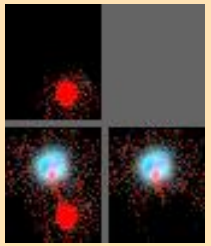

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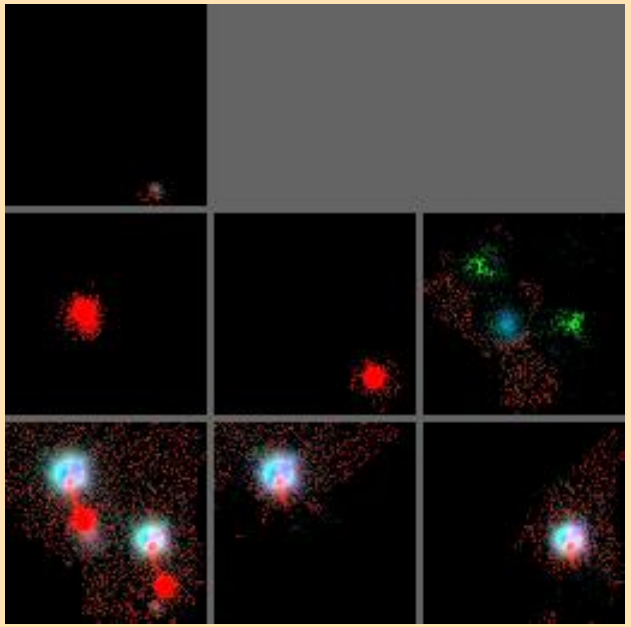

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Is Anything Left?

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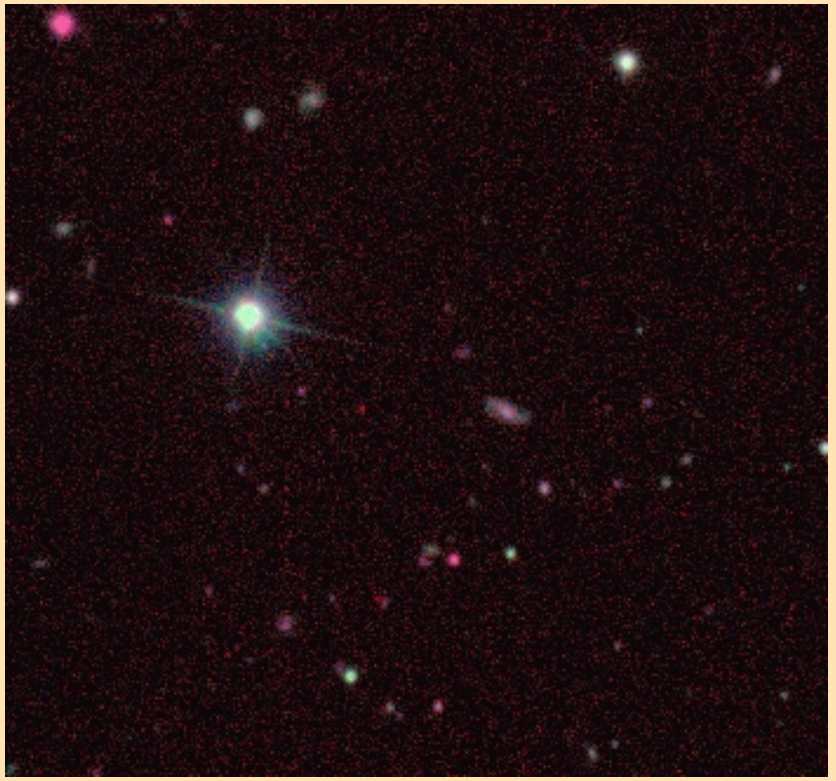

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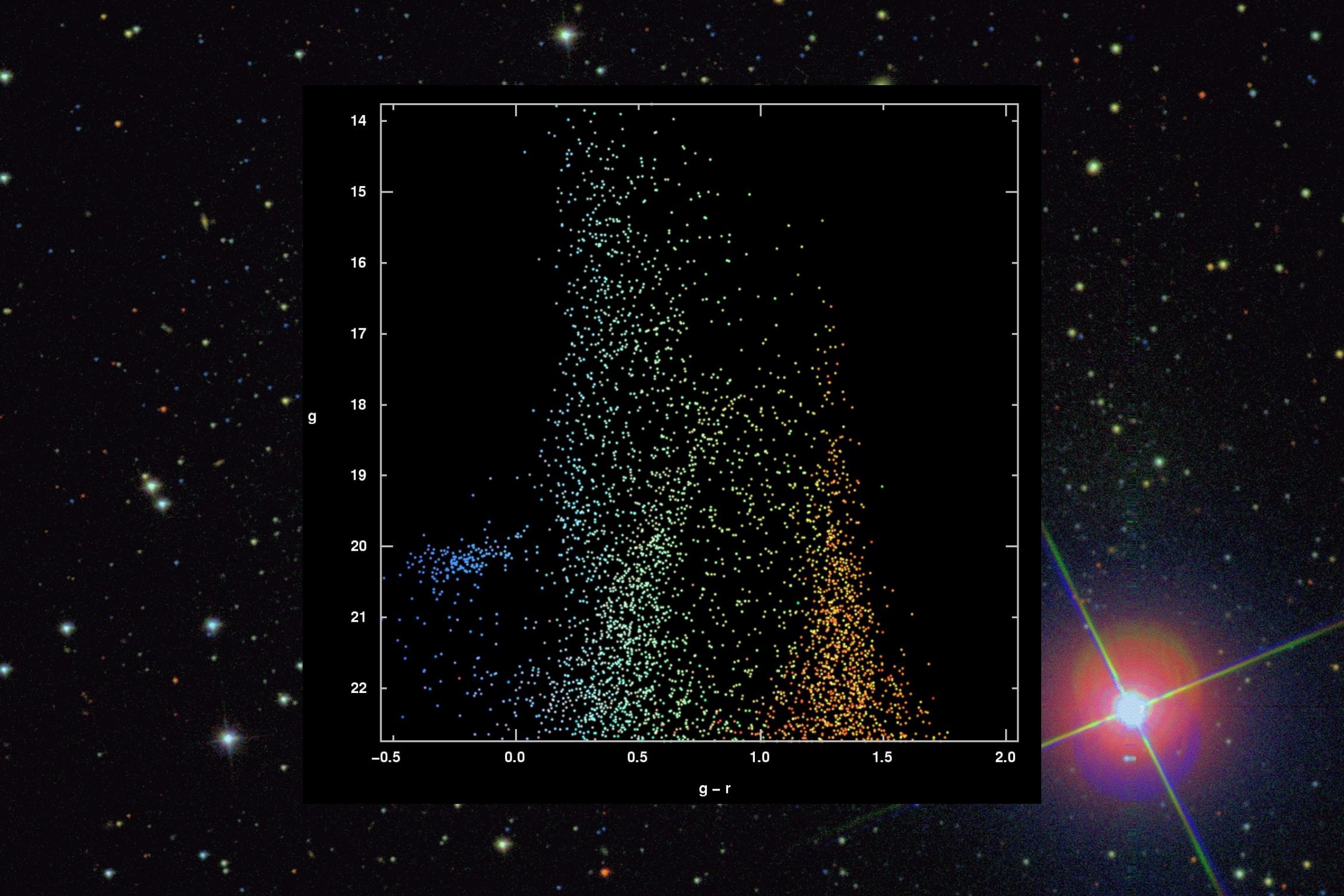
Recommendation: Advertise a tenured faculty position


The End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