Hunting for brown dwarf binaries with X-Shooter

Elena Manjavacas

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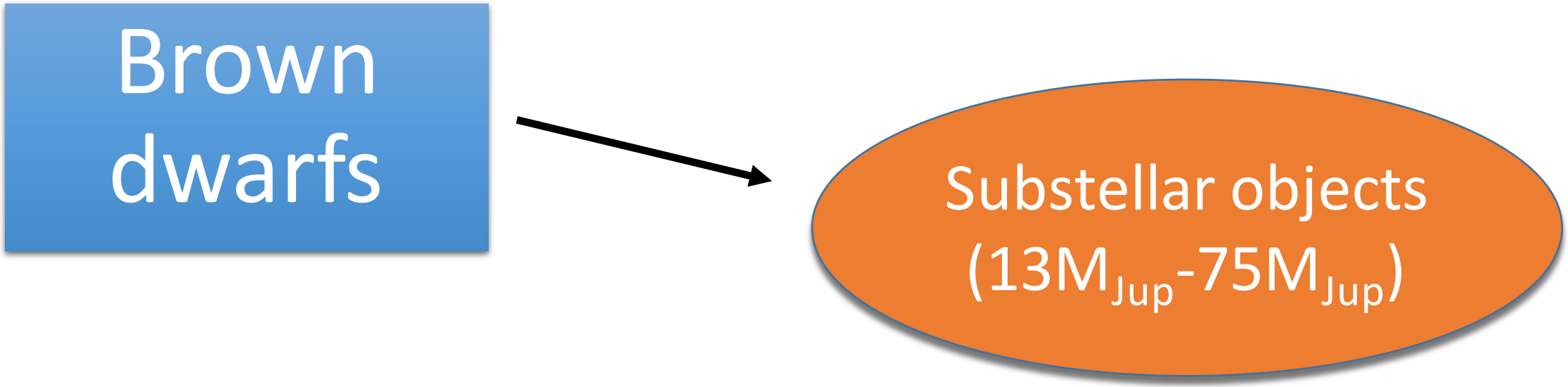
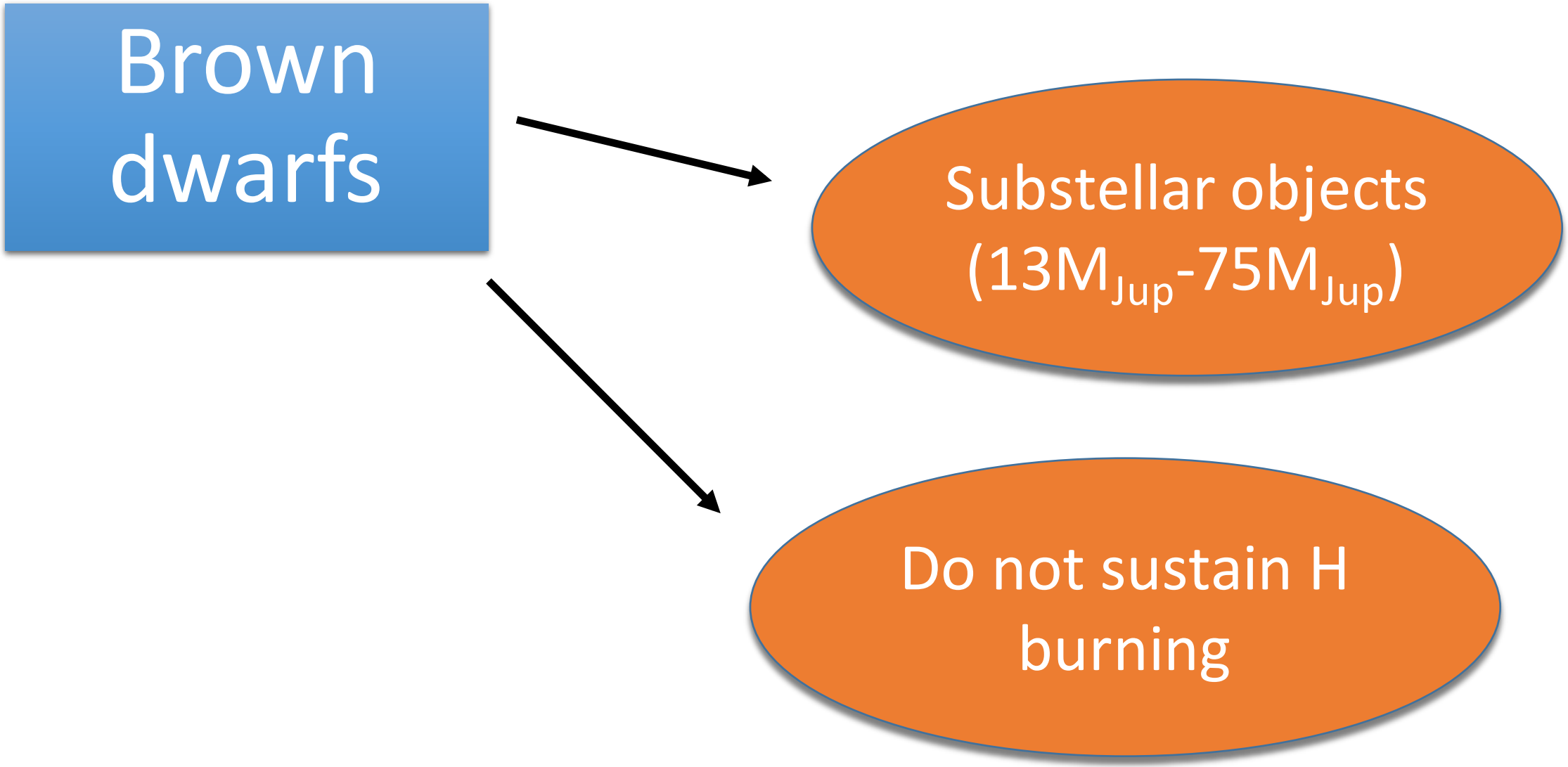
EMIR postdoctoral fellow

Instituto de Astrofísica de Canarias

Brown dwarfs


Brown dwarfs
Substellar objects
(13M$_{Jup}$-75M$_{Jup}$)


Brown dwarfs
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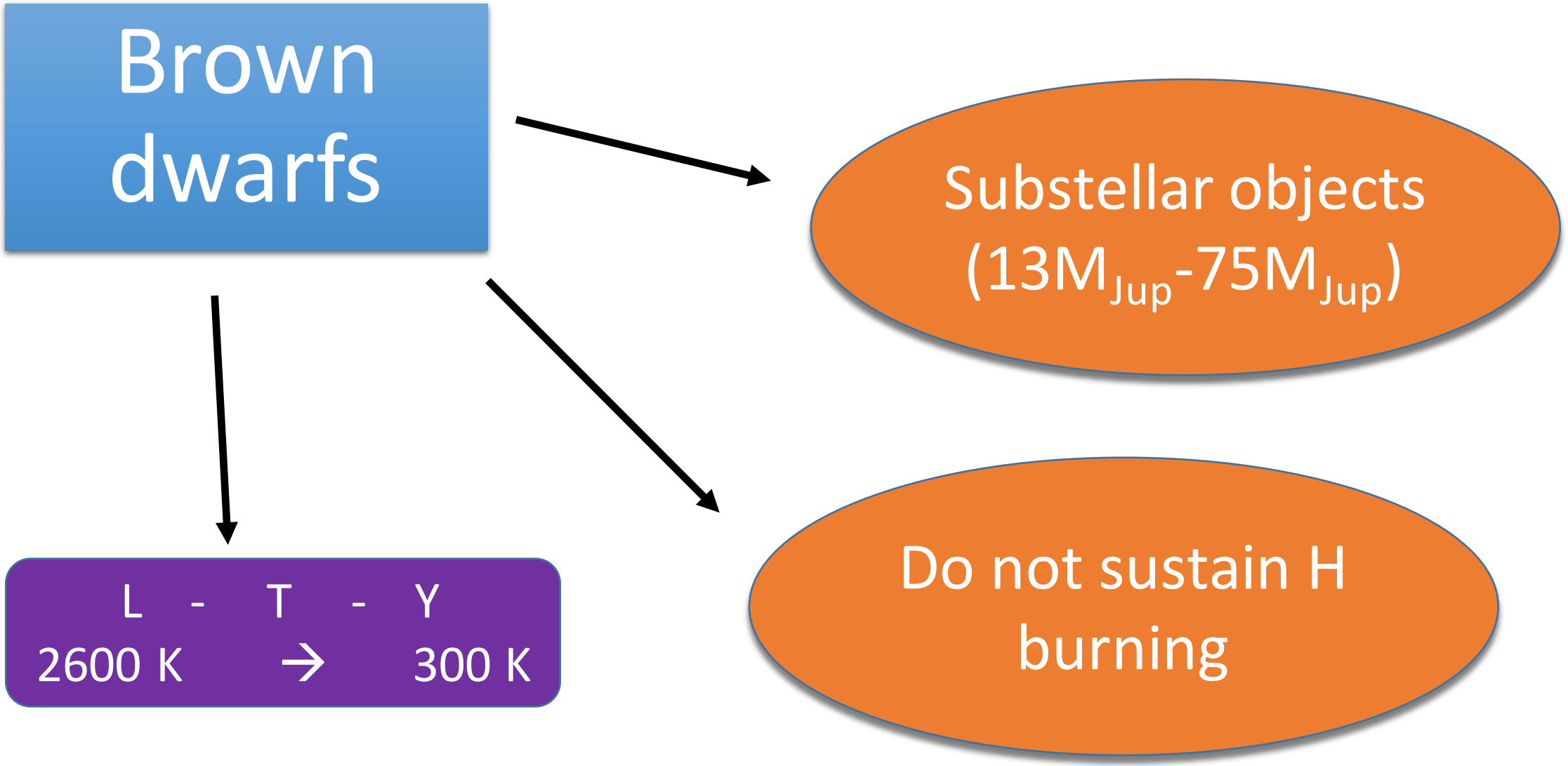
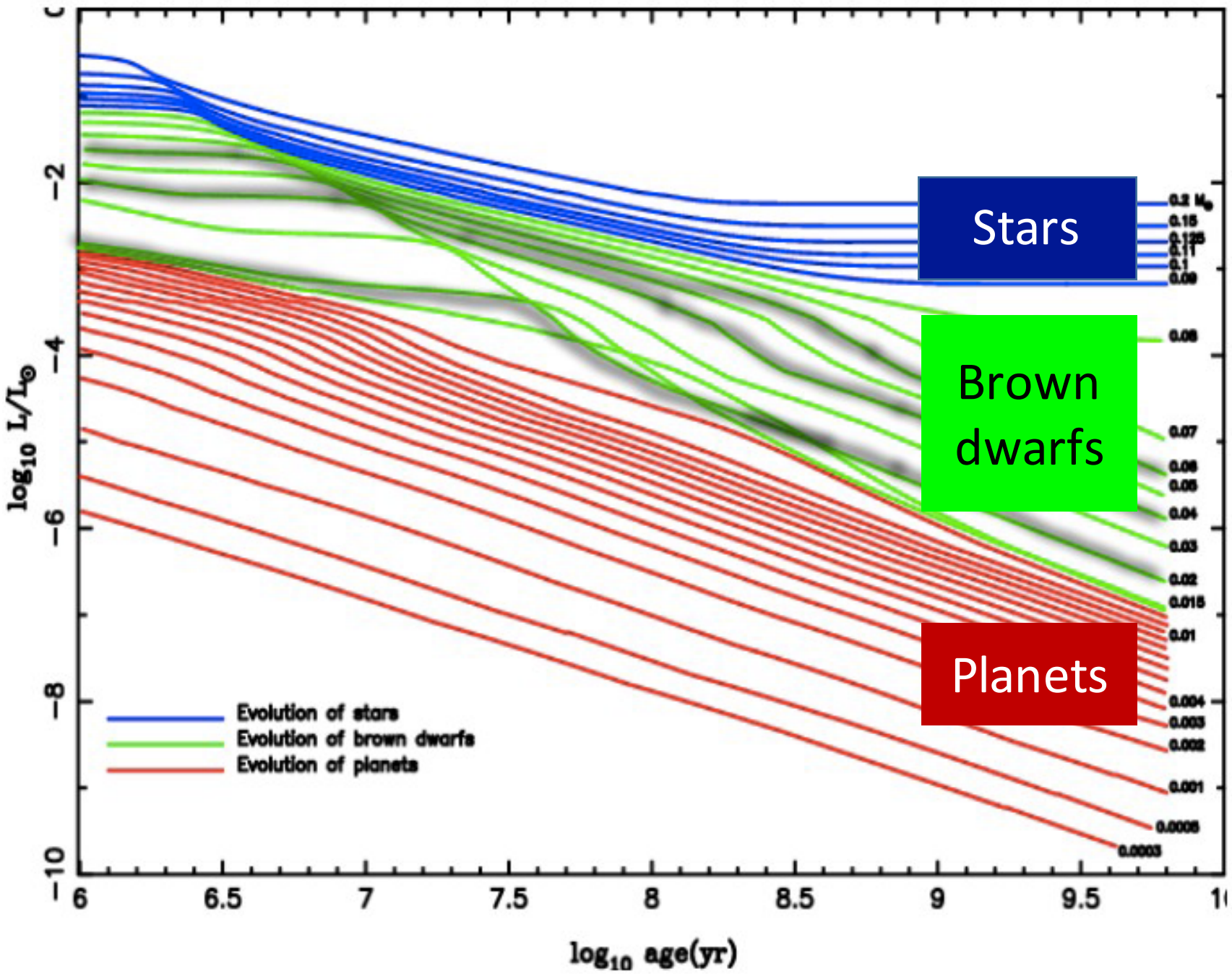
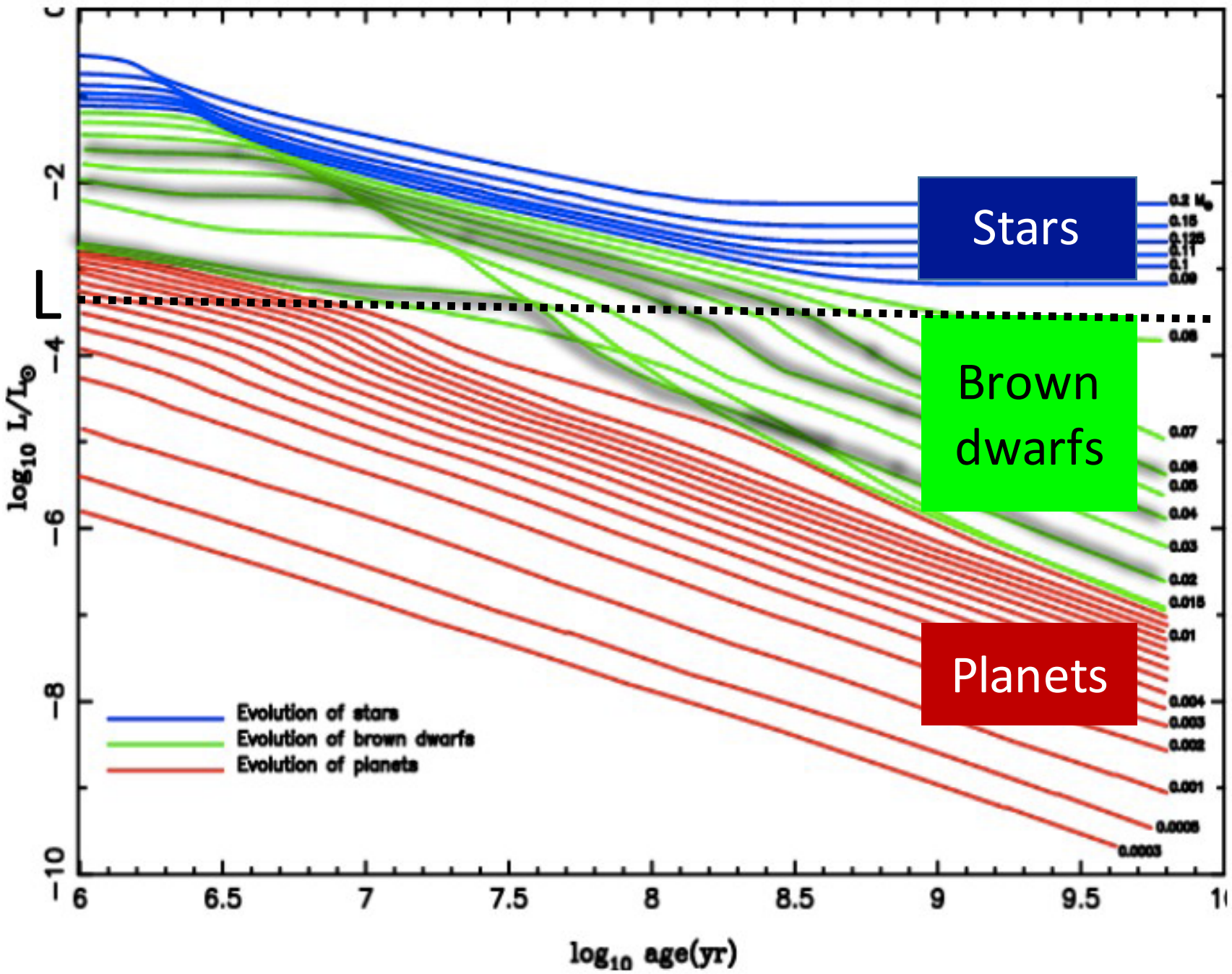
Do not sustain H burning


Brown dwarfs
Substellar objects (13M$_{Jup}$-75M$_{Jup}$)
Do not sustain H burning
L - T - Y
2600 K → 300 K



Burrows+ 2001



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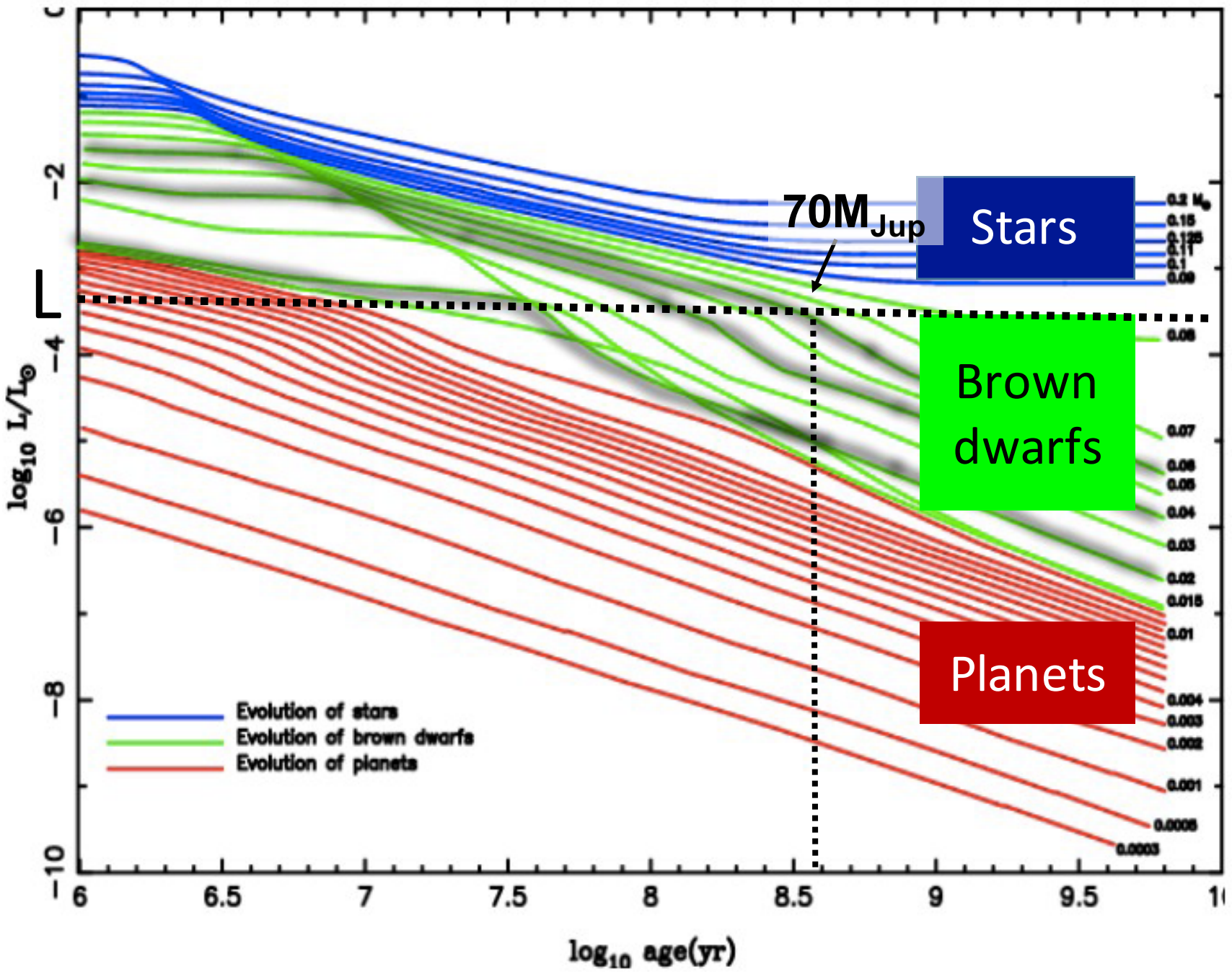

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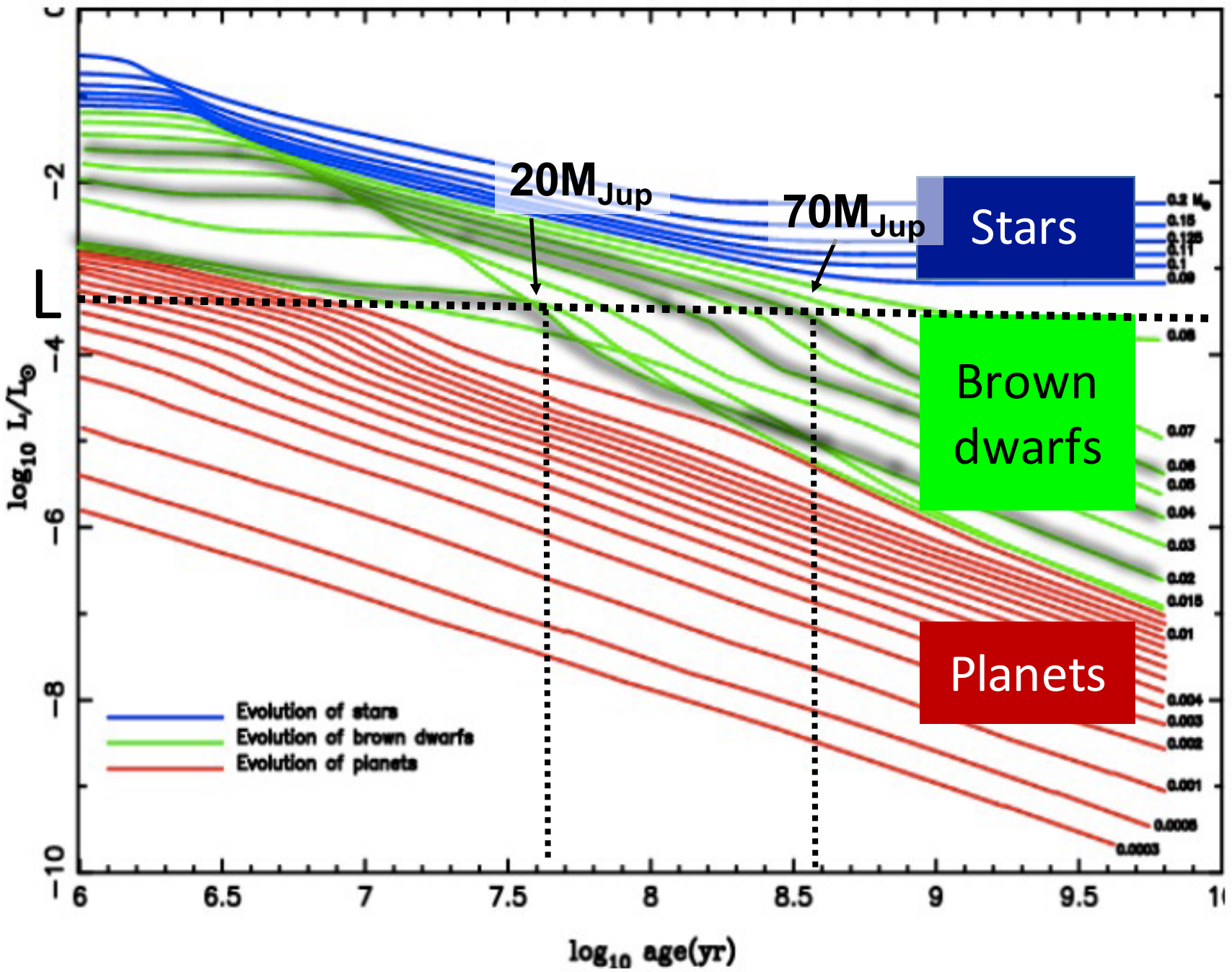
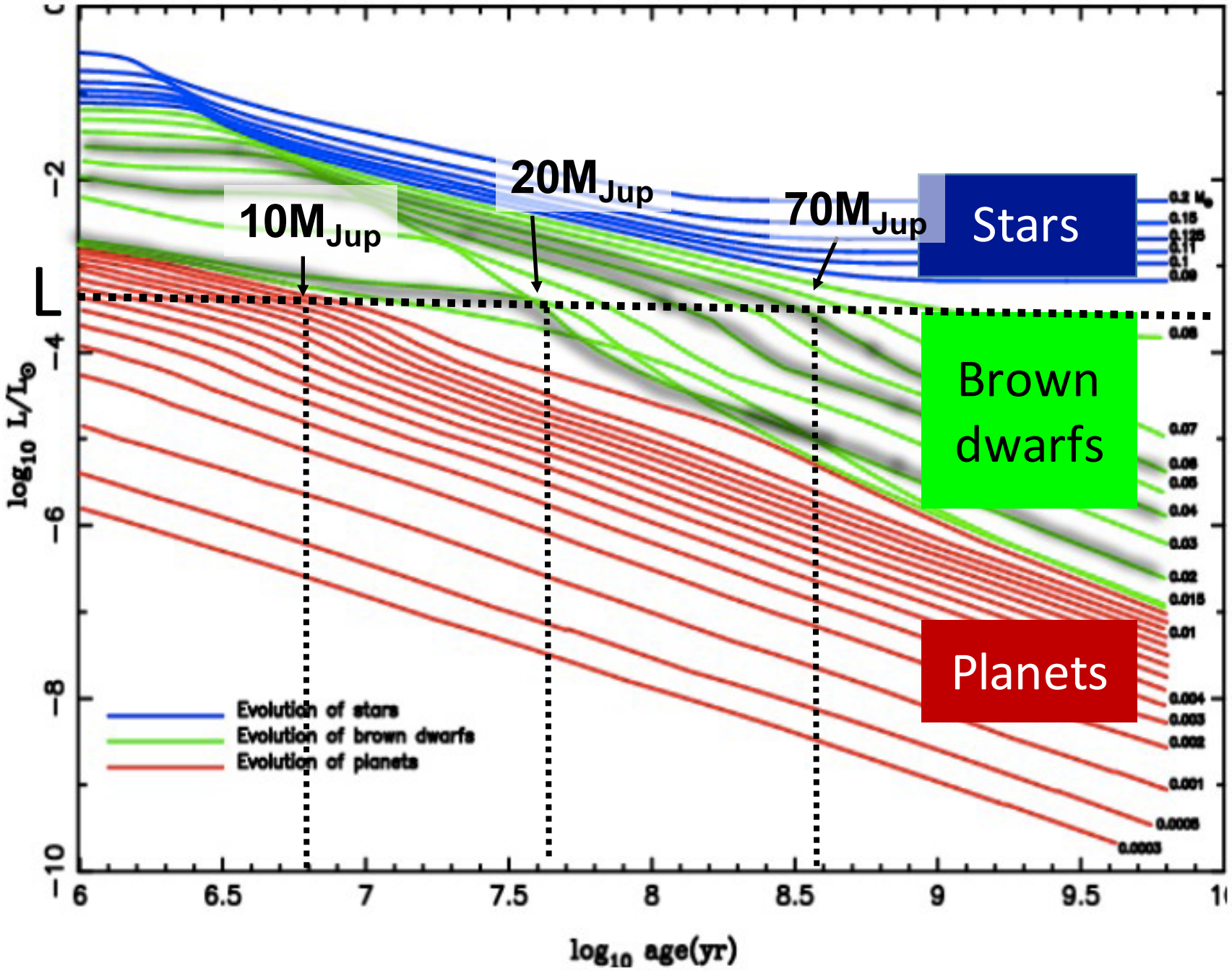


Burrows+ 2001



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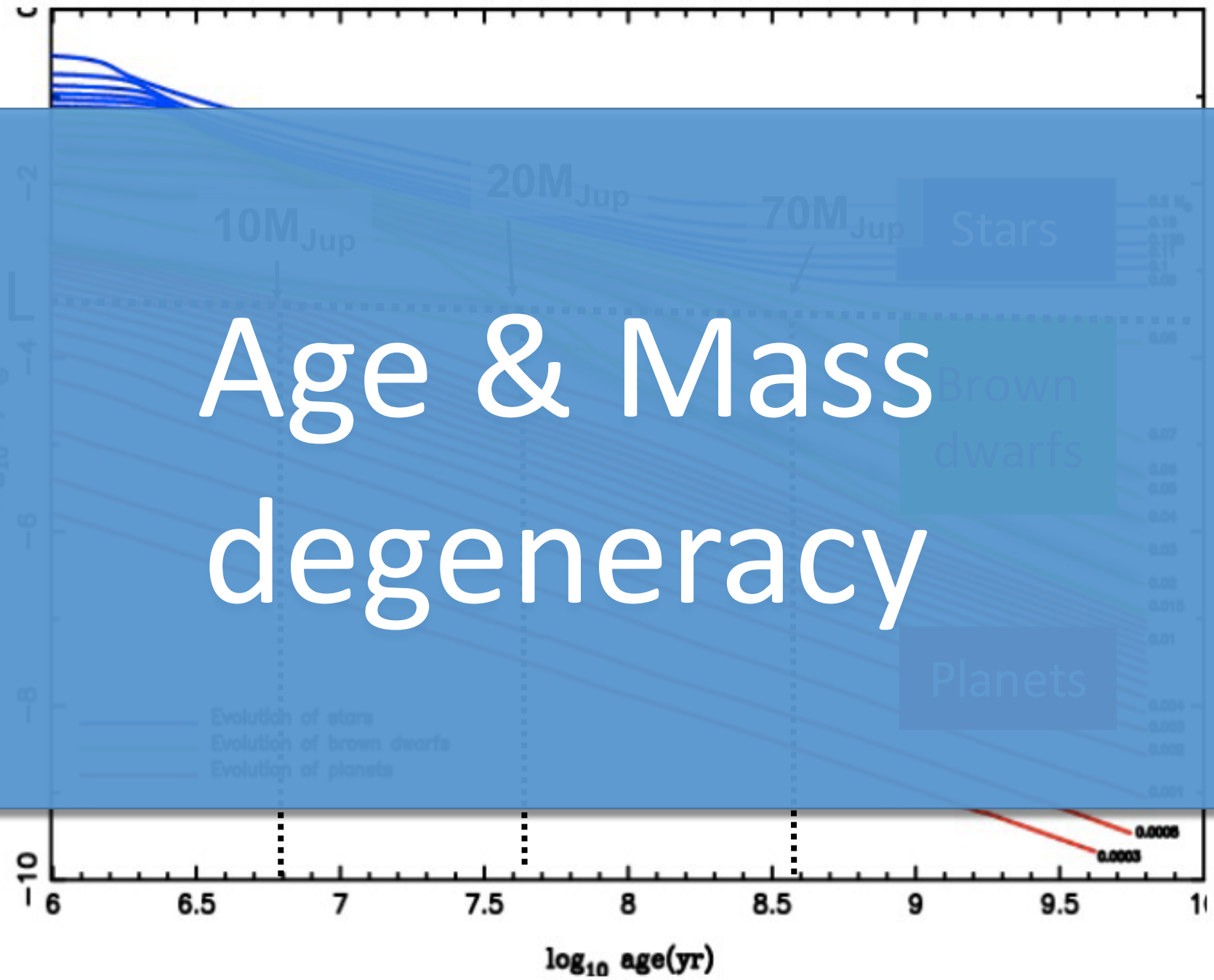

Age & Mass degeneracy

Burrows+ 2001

Why is important to study brown dwarf binaries?

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Estimate the BD binary fraction

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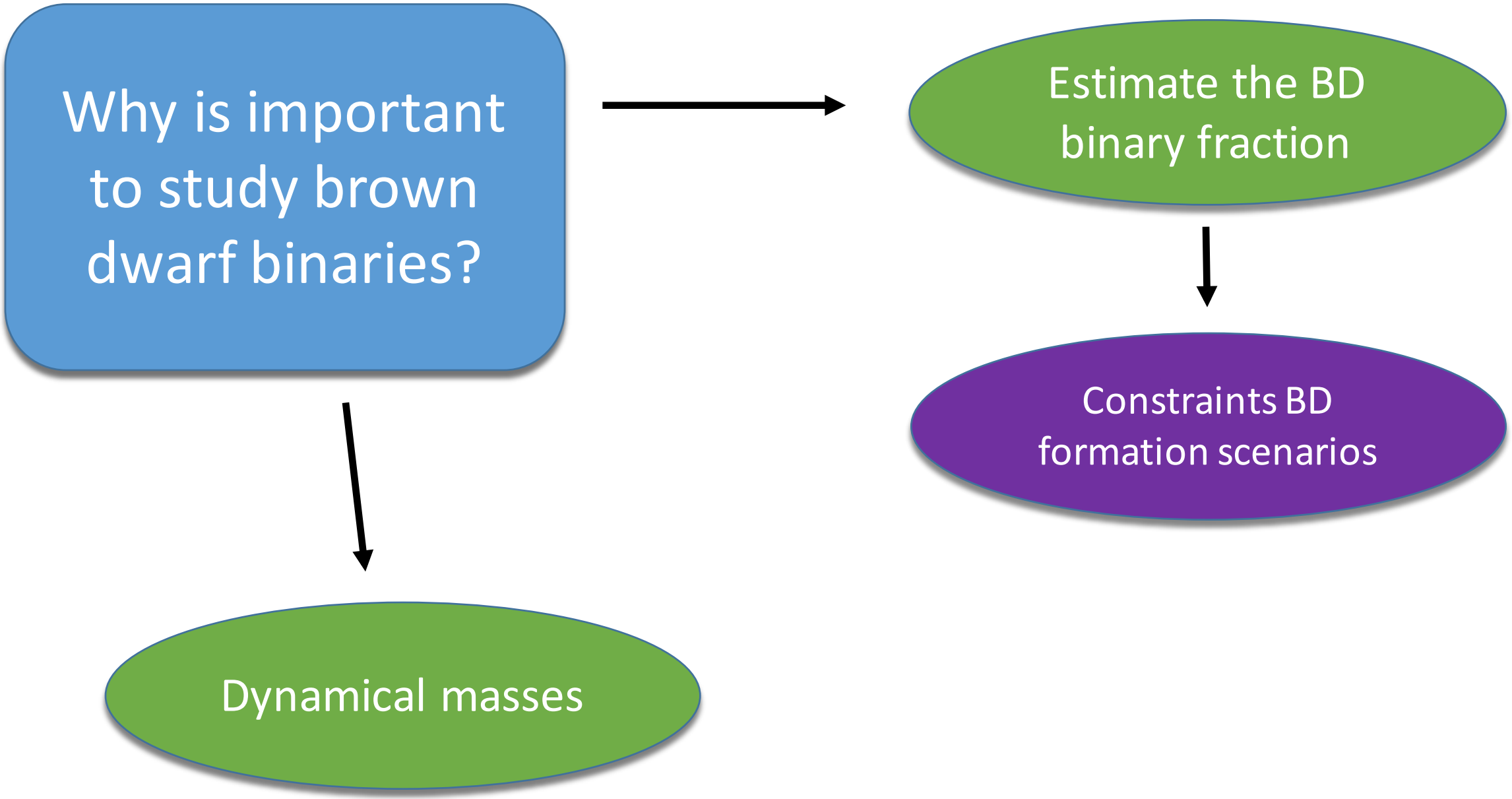
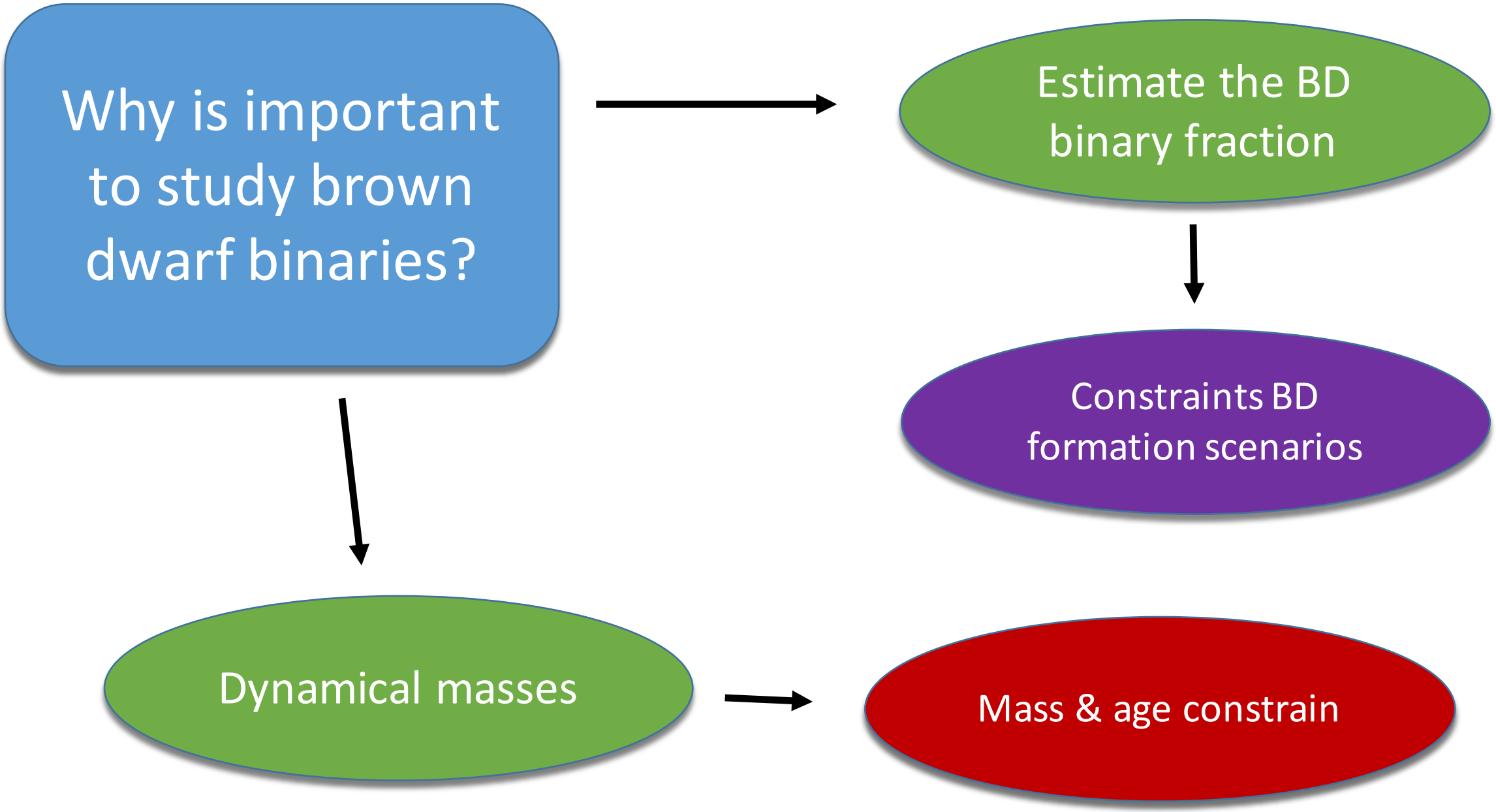
Estimate the BD binary fraction

Constraints BD formation scenarios


Why is important to study brown dwarf binaries?
Estimate the BD binary fraction
Constraints BD formation scenarios
Dynamical masses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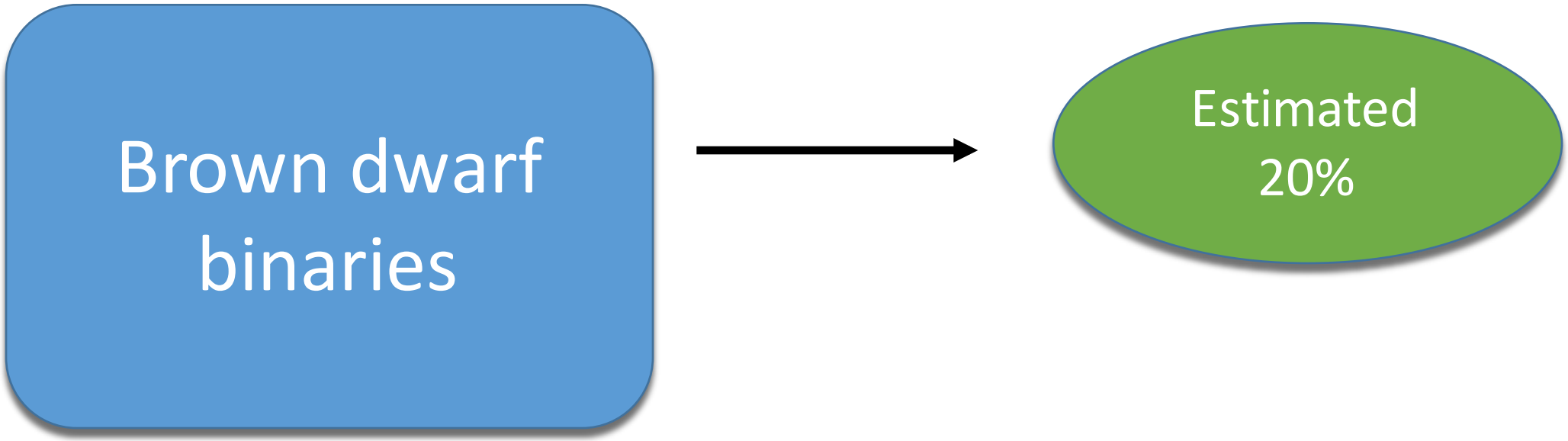
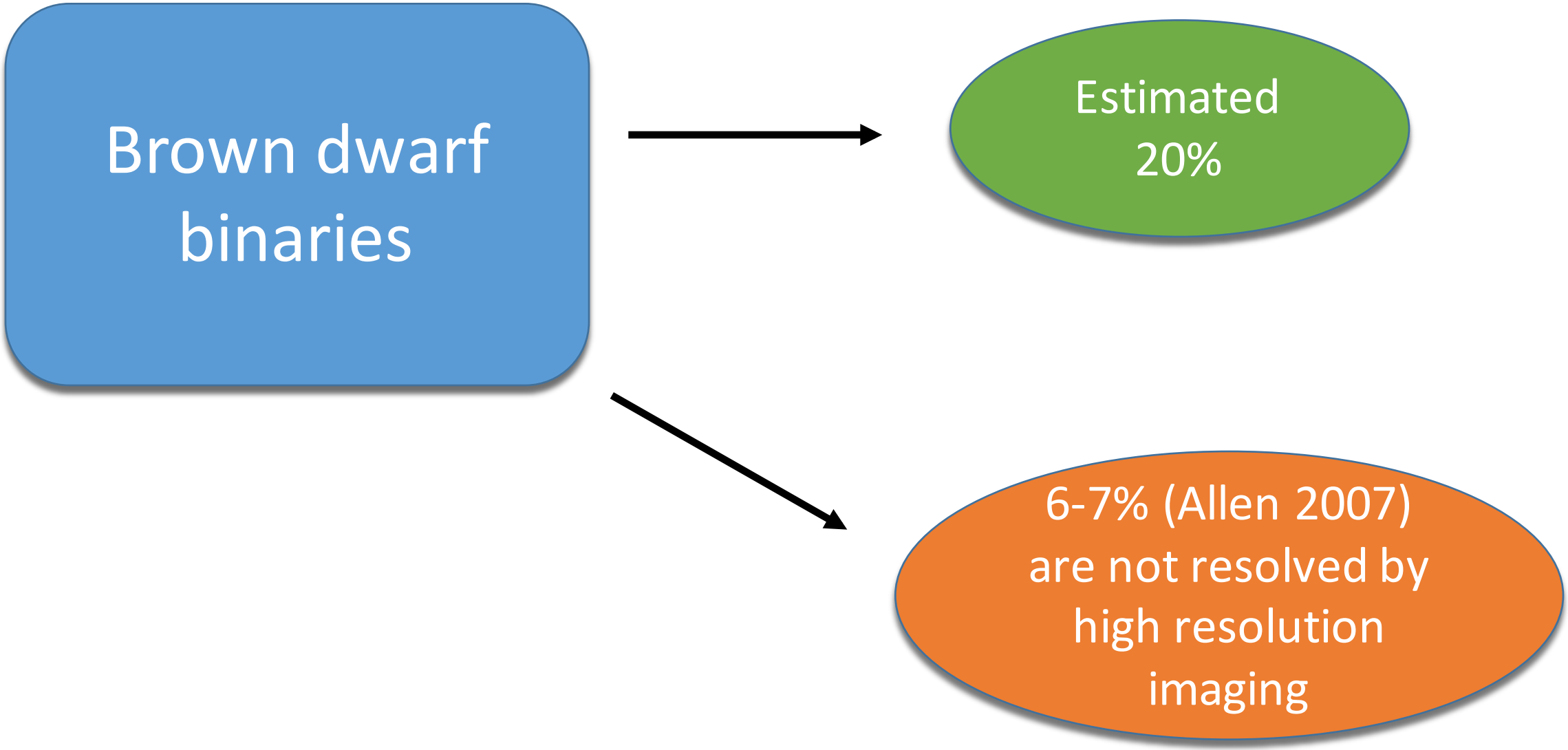
Brown dwarf binaries


Brown dwarf binaries
Estimated 20%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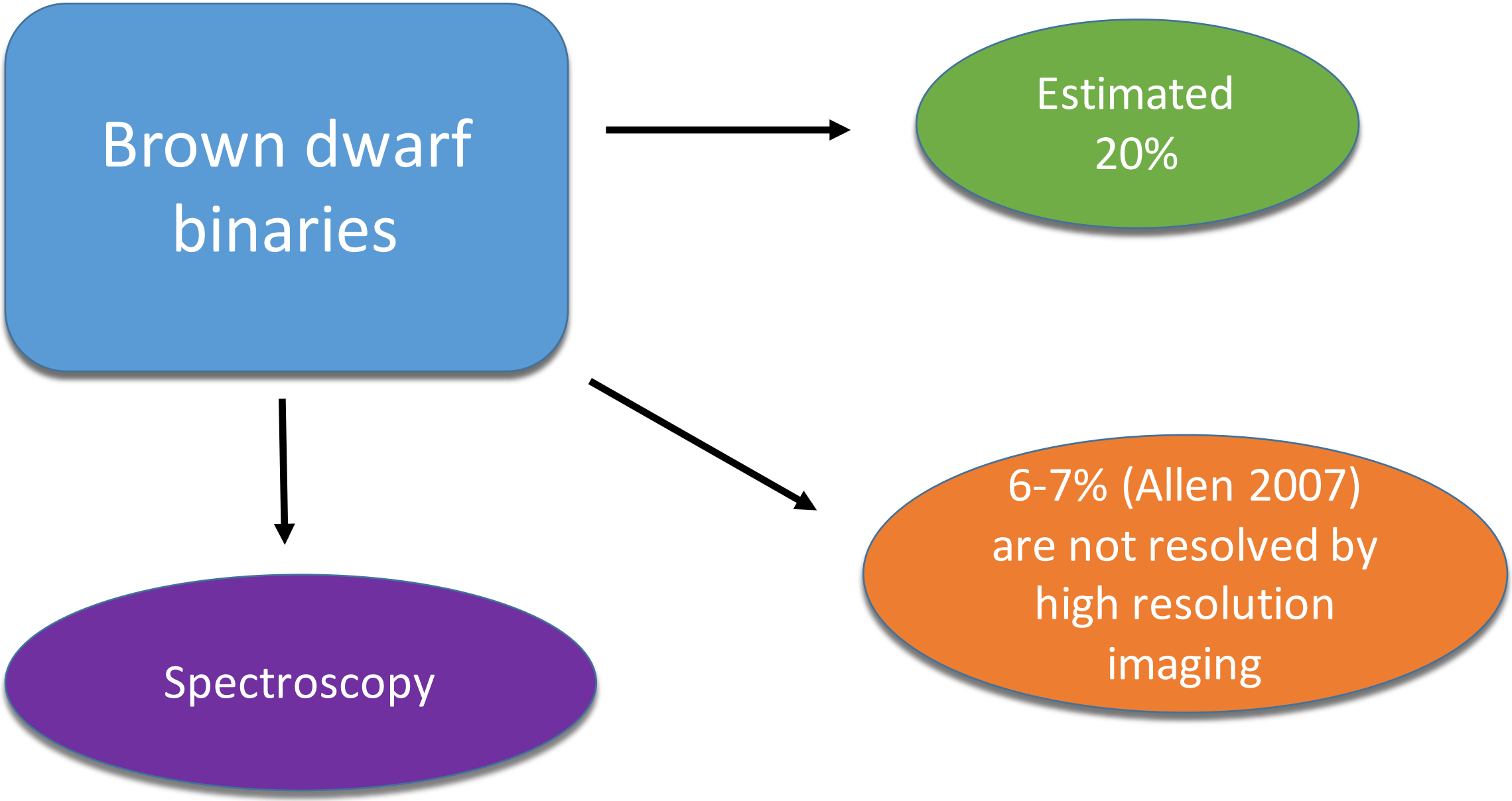
6-7% (Allen 2007) are not resolved by high resolution imaging


Brown dwarf binaries
Estimated 20%
Spectroscopy
6-7% (Allen 2007) are not resolved by high resolution imaging

X-Shooter (500 nm-2500 nm) spectra of 22 objects

1 L+L known binary

1 L+T known binary

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Different classification in OPTICAL/NIR

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Peculiar

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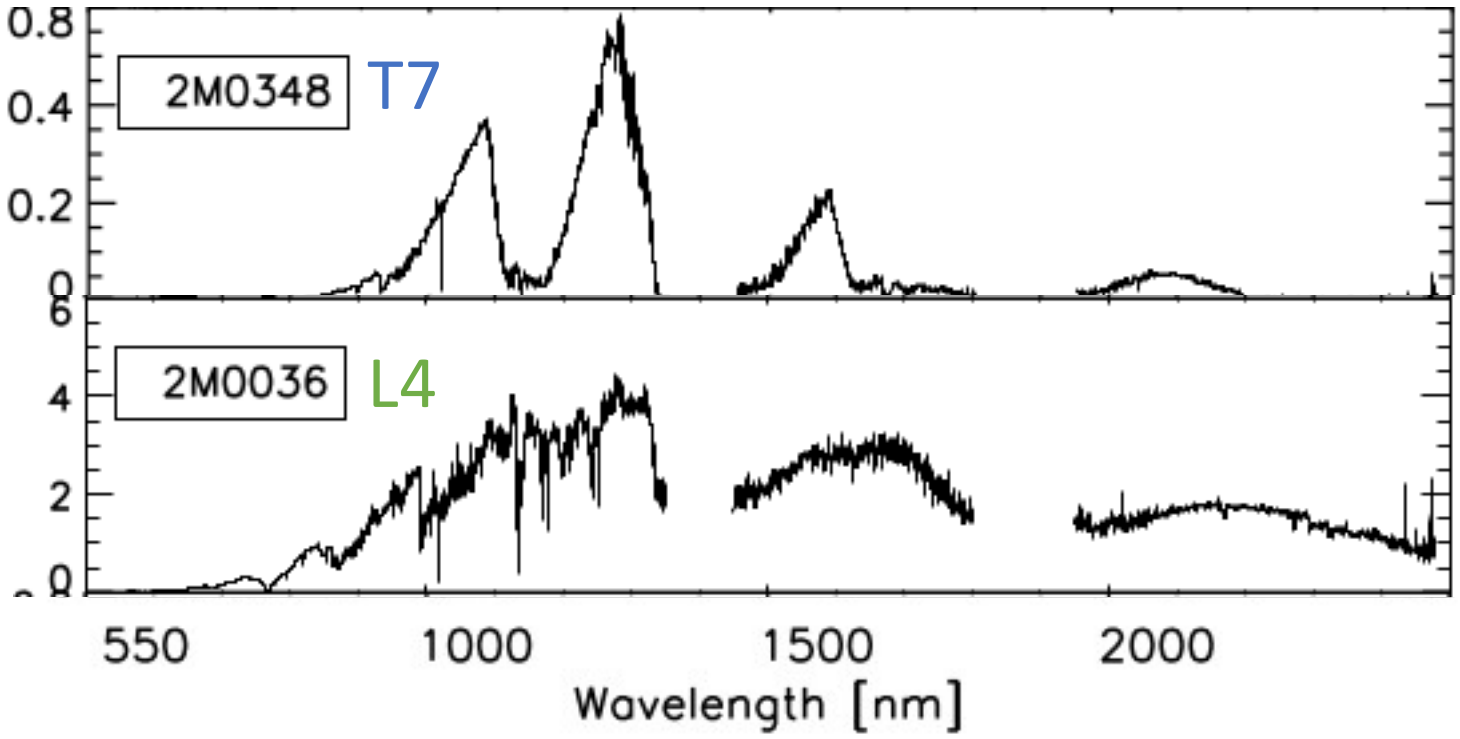
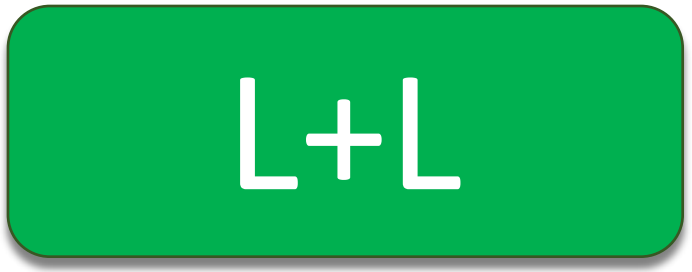


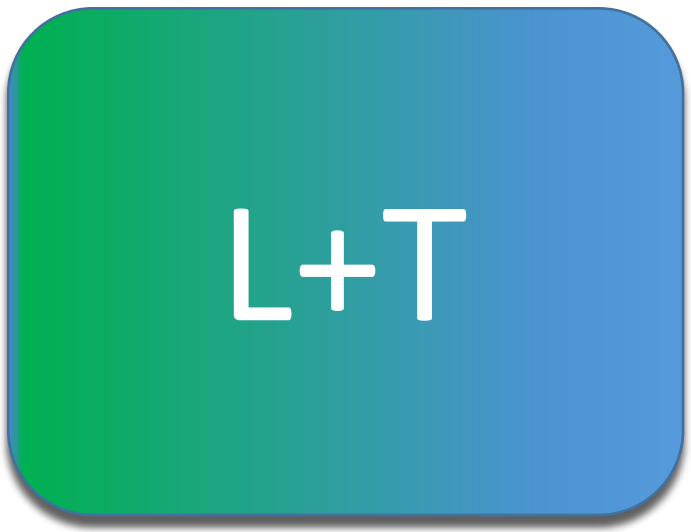
Different classification in OPTICAL/NIR

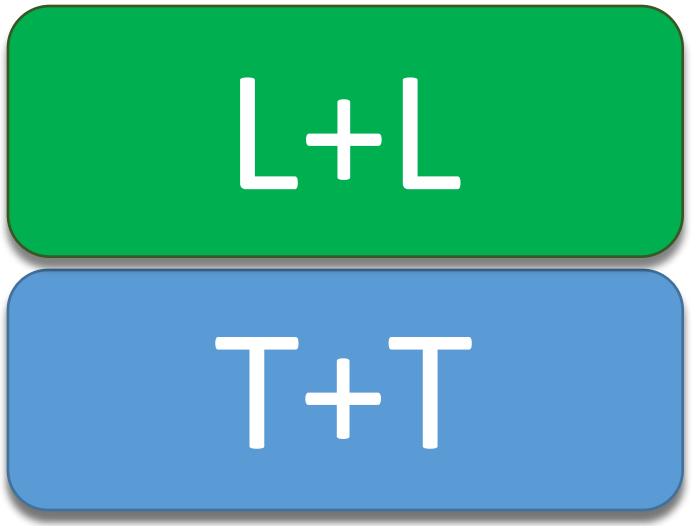
Peculiar


L+T

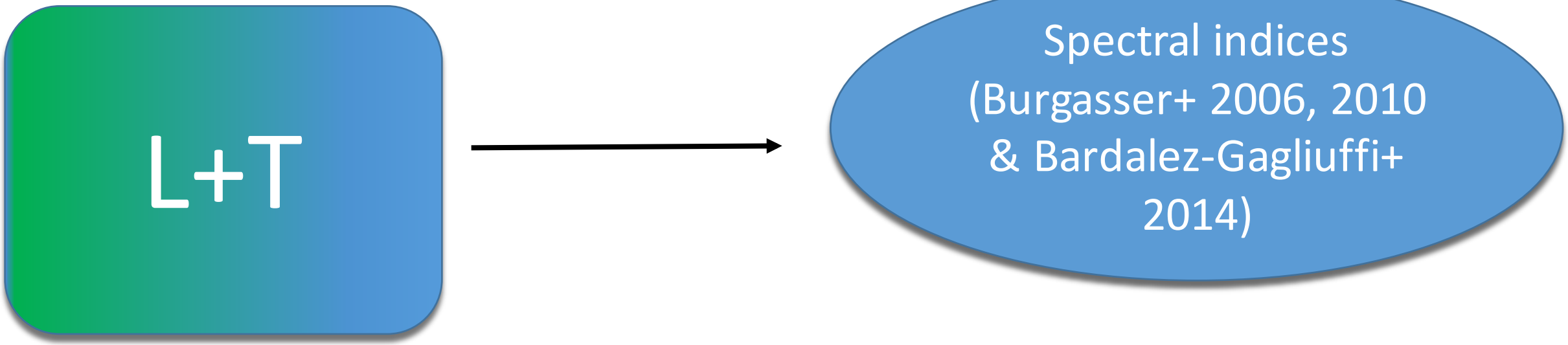

L+T


L+L


L+T


L+L
T+T

L+T


L+T
Spectral indices
(Burgasser+ 2006, 2010
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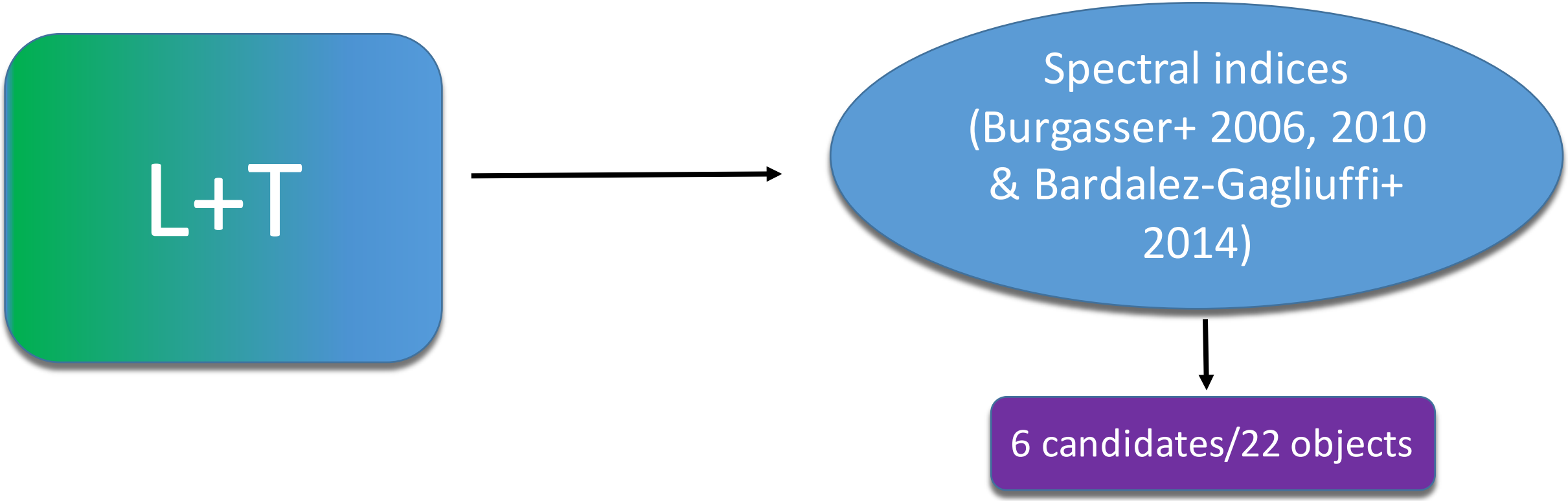
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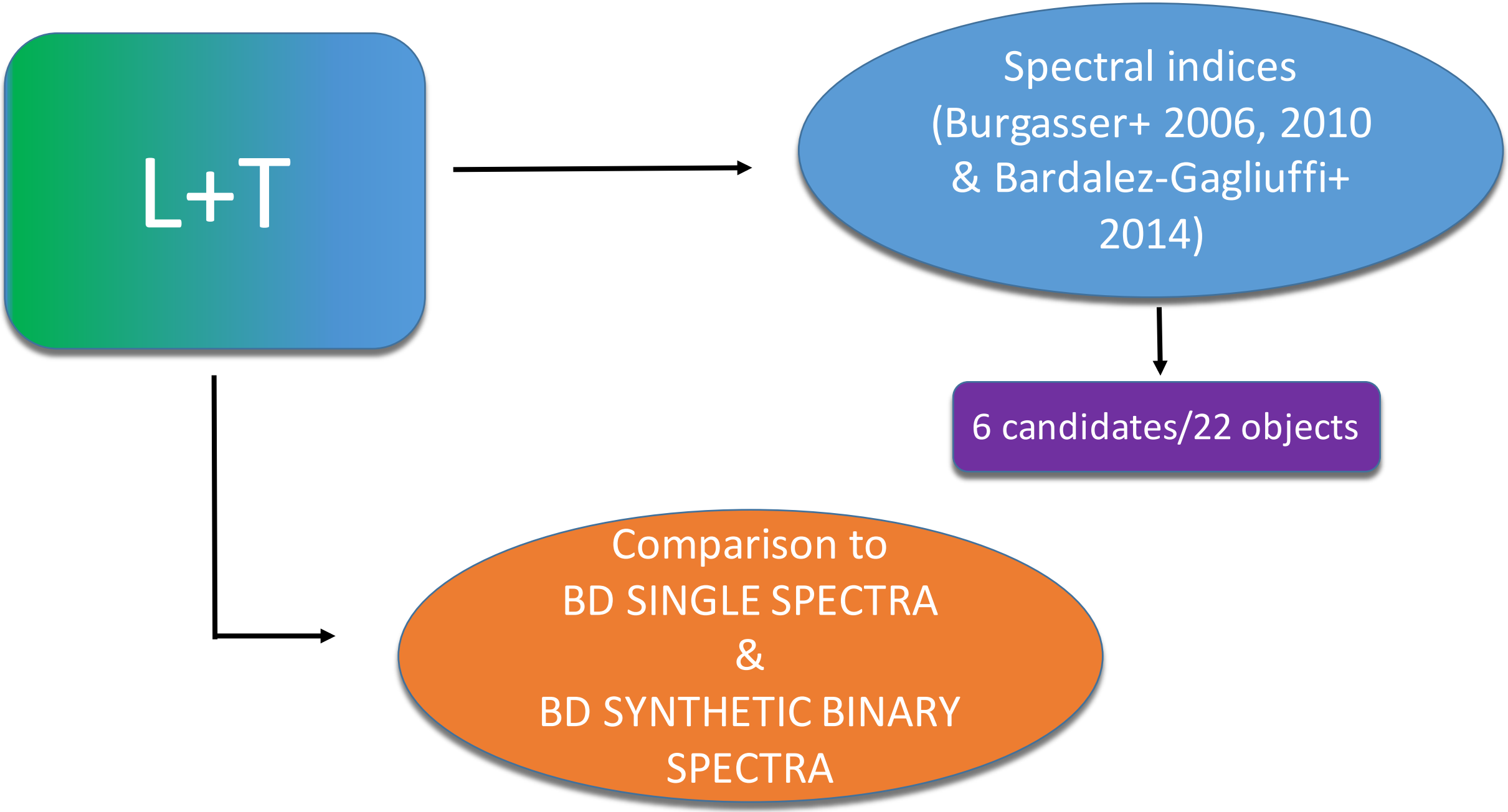
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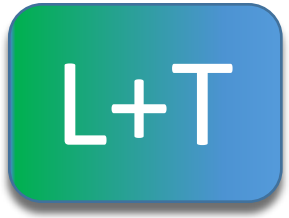
Comparison to
BD SINGLE SPECTRA
&
BD SYNTHETIC BINARY
SPECTRA


L+T

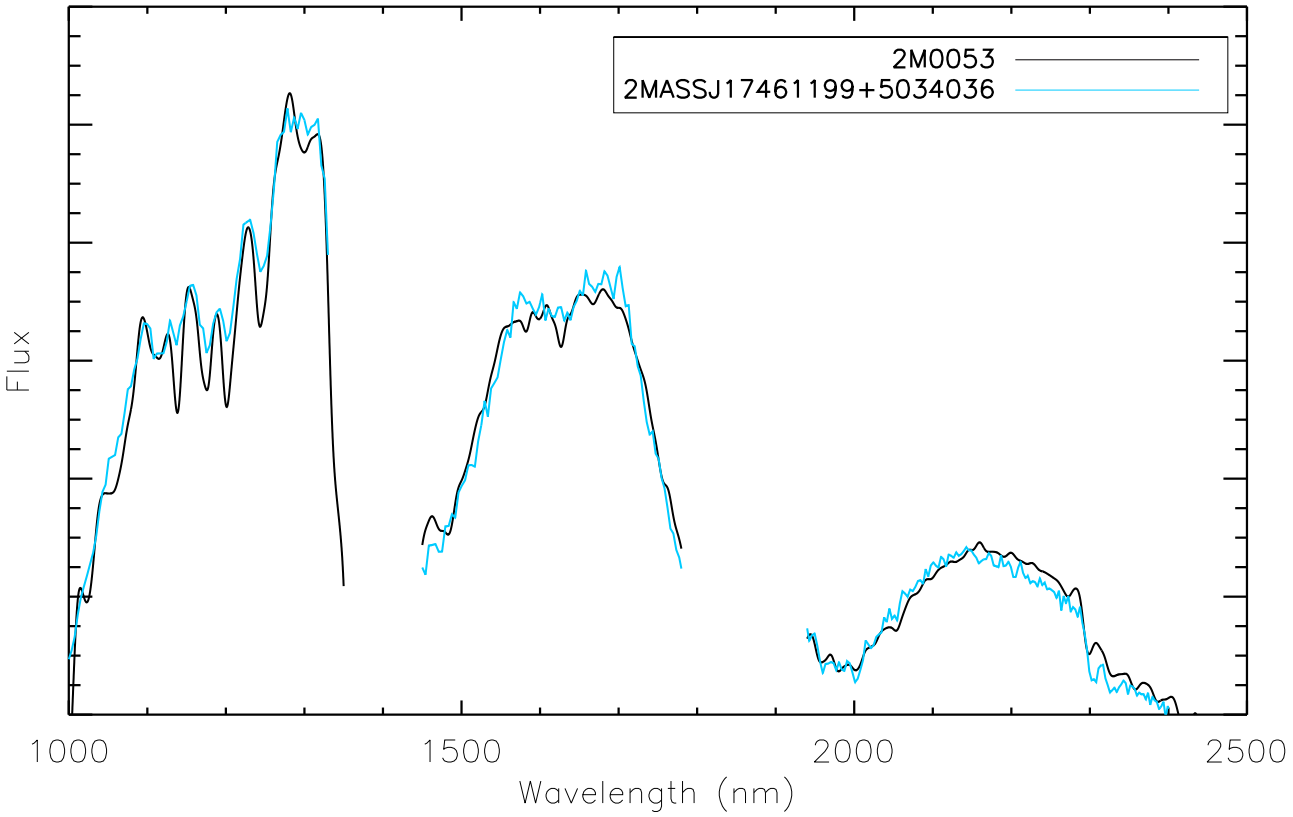
L+T

BD SINGLE SPECTRA

L+T

Min χ^2_{single}

BD SINGLE SPECTRA

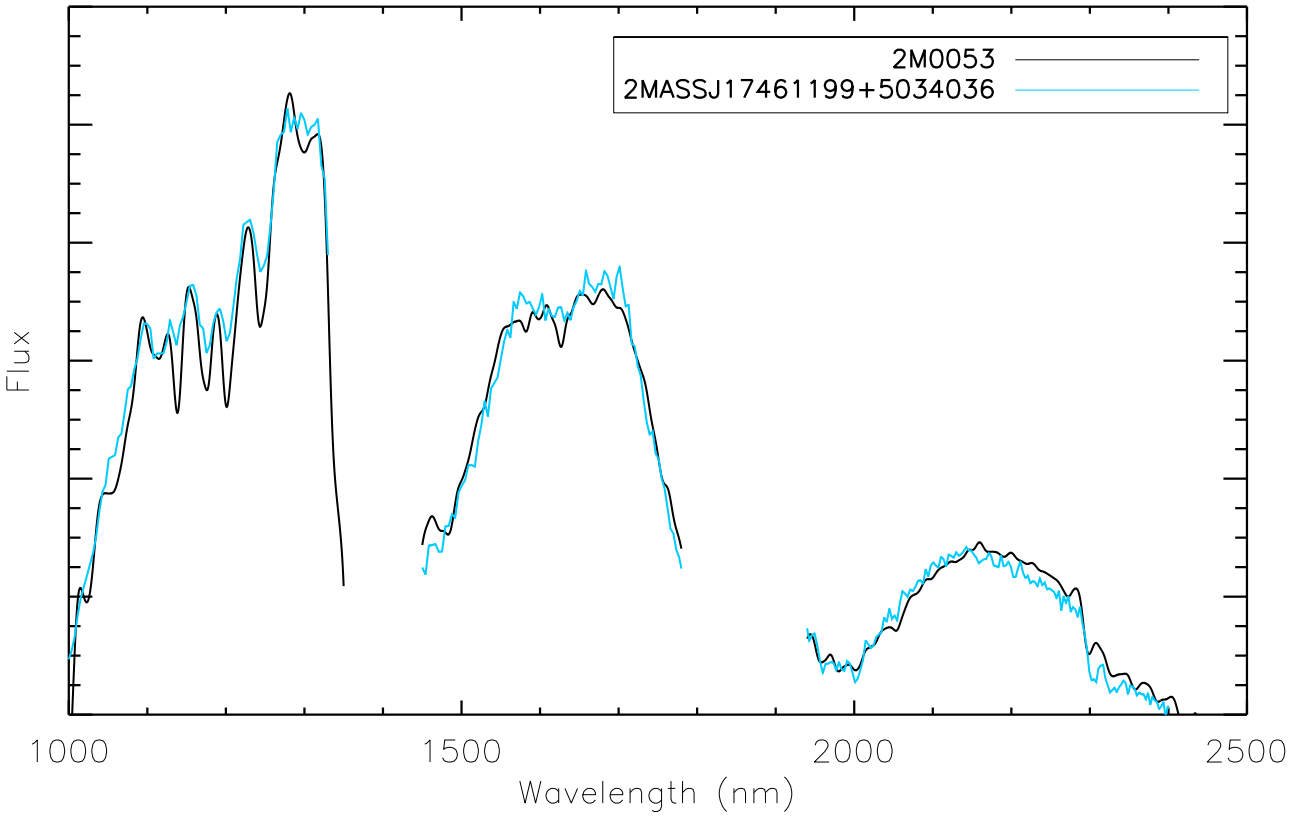


L+T

$$\text{Min } \chi^2_{\text{single}}$$

BD SINGLE SPECTRA

BD SYNTHETIC BINARY SPECTRA



L+T

Min χ^2_{single}

Min $\chi^2_{Synthetic\ binary}$

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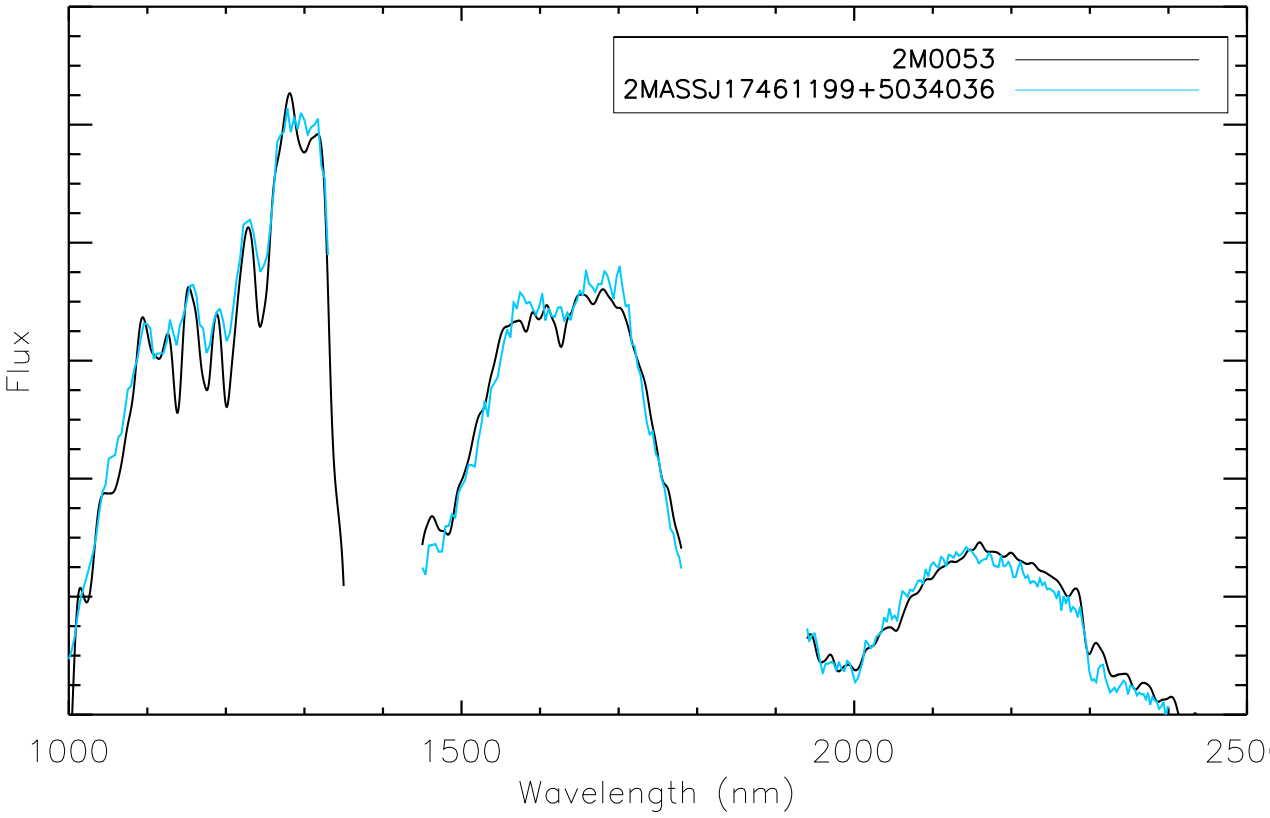

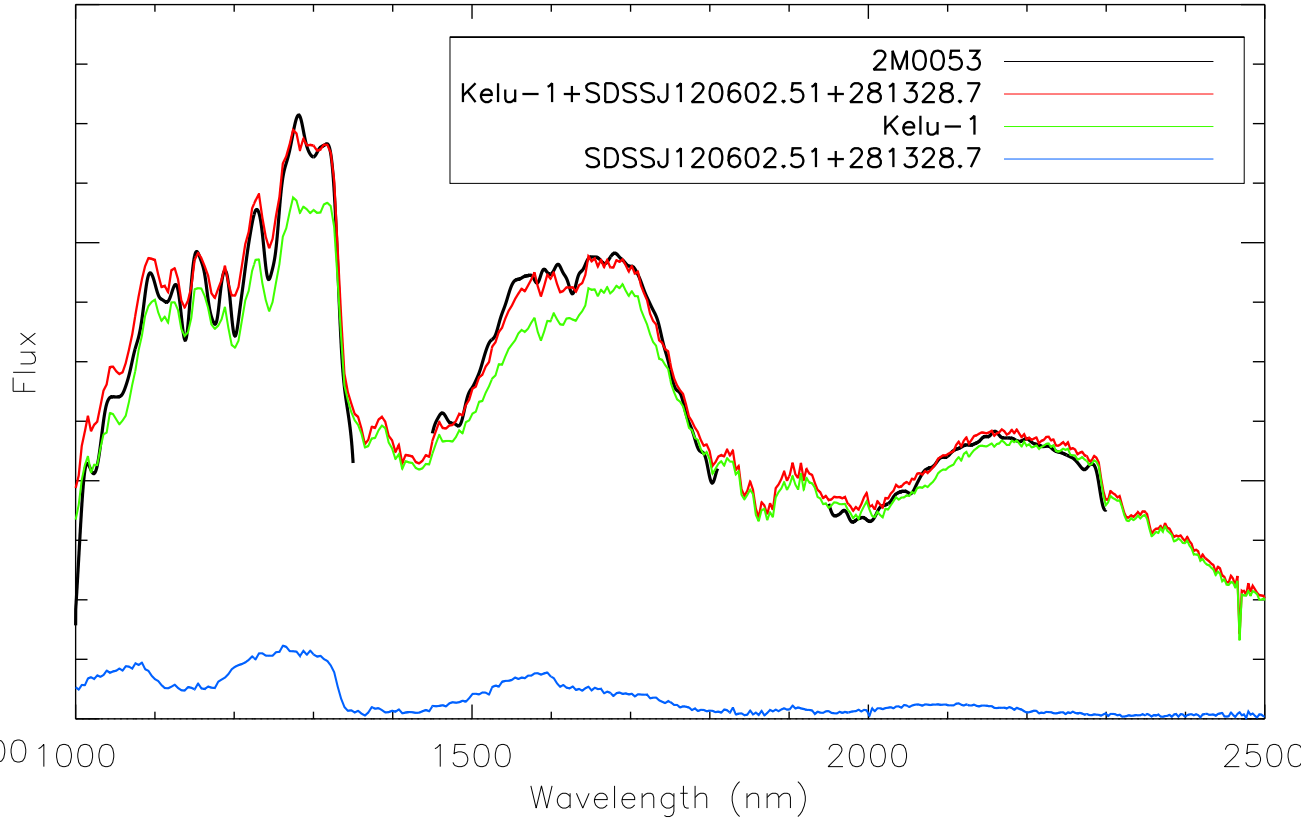

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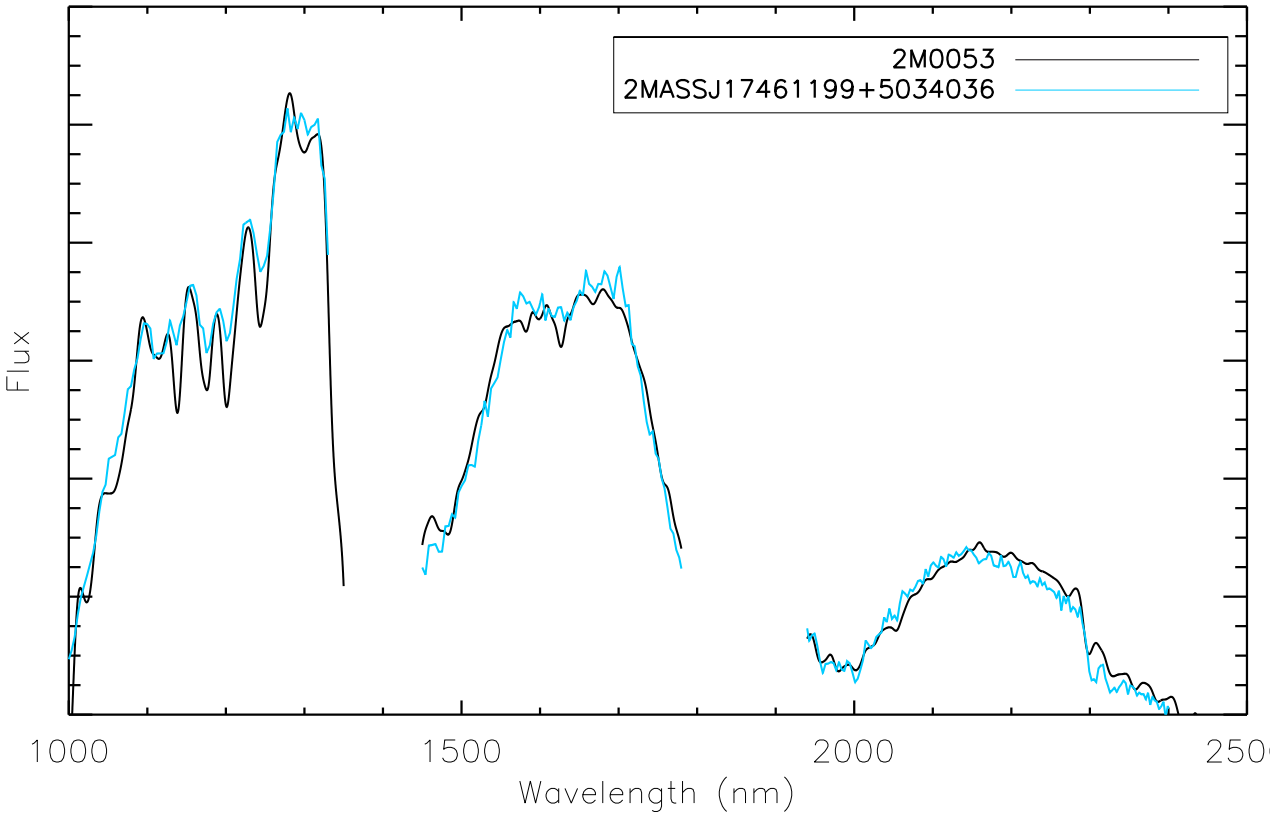
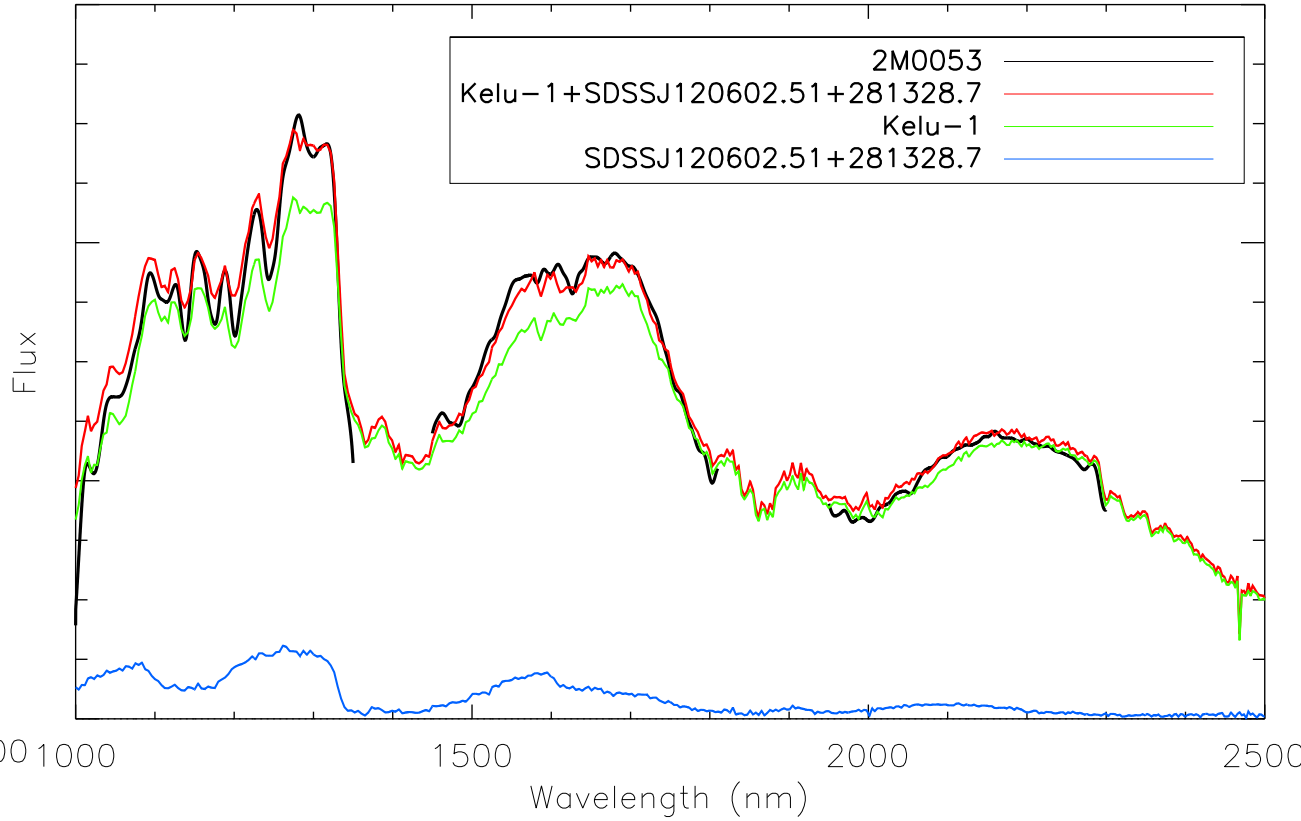


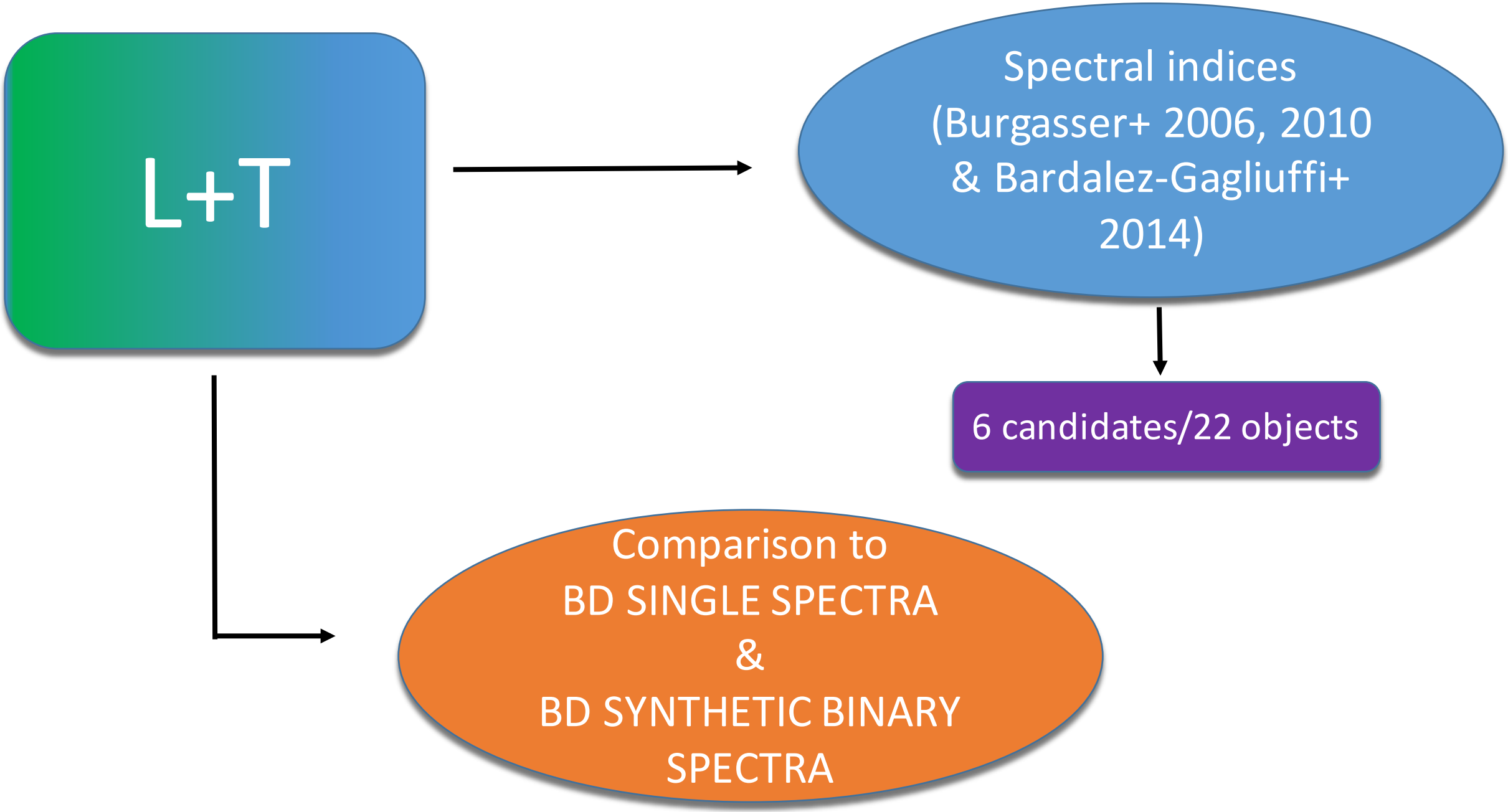


η

$$\eta = \frac{\mathrm{Min}(\chi^2_{\mathrm{Single}}) \,/\, \mathrm{dof}_{\mathrm{single}}}{\mathrm{Min}(\chi^2_{\mathrm{Synthetic\ binary}}) \,/\, \mathrm{dof}_{\mathrm{Synthetic\ binary}}}$$

$$\eta = \frac{\mathrm{Min}(\chi^2_{\mathrm{Single}}) / \mathrm{dof}_{\mathrm{single}}}{\mathrm{Min}(\chi^2_{\mathrm{Synthetic\ binary}}) / \mathrm{dof}_{\mathrm{Synthetic\ binary}}} > 1.31$$

99% Binary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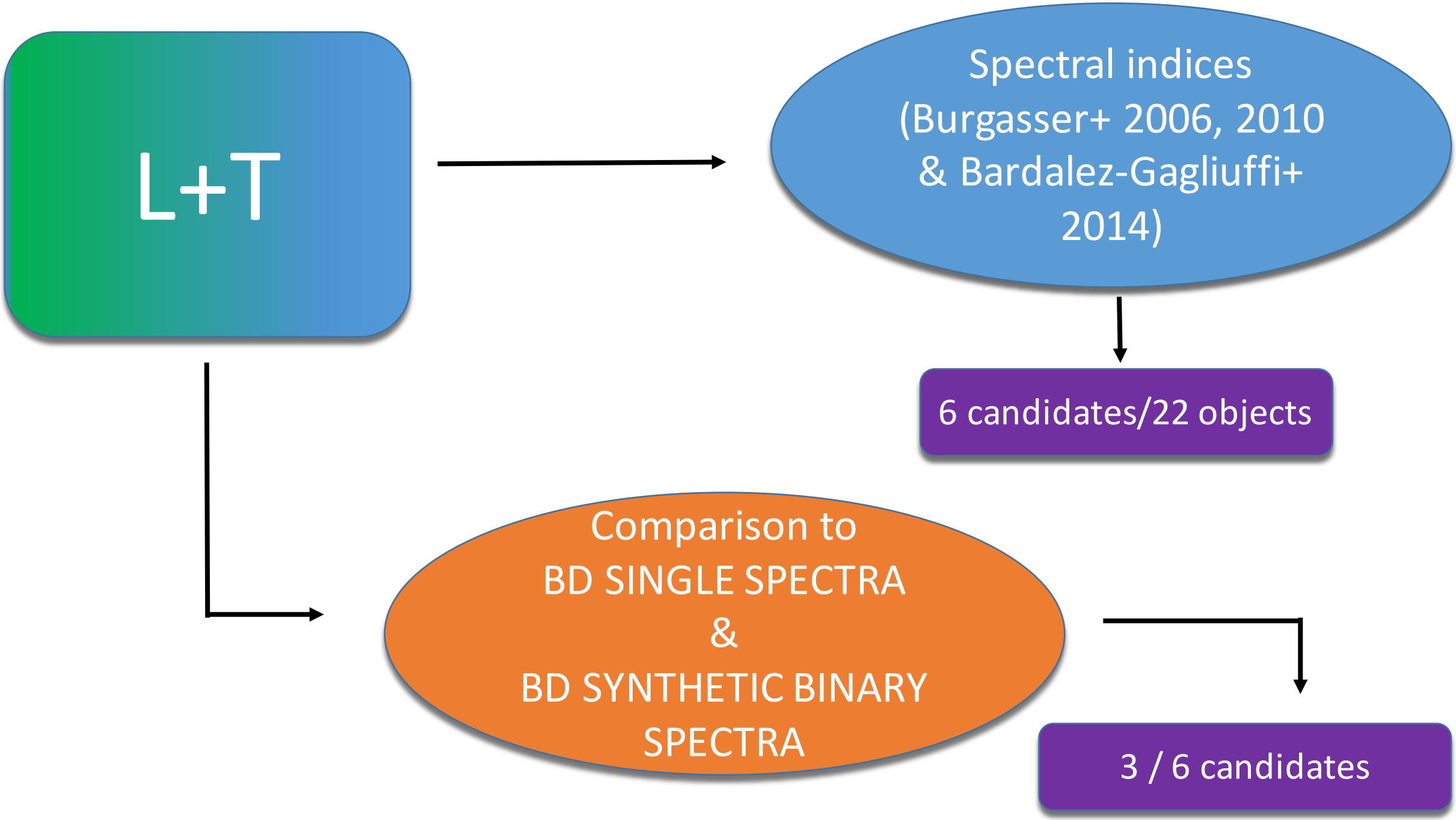
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Comparison to
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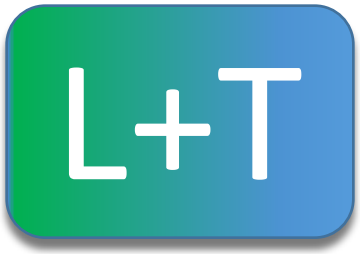
SPECTRA
3 / 6 candidates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Fraction of L+T binaries missing?

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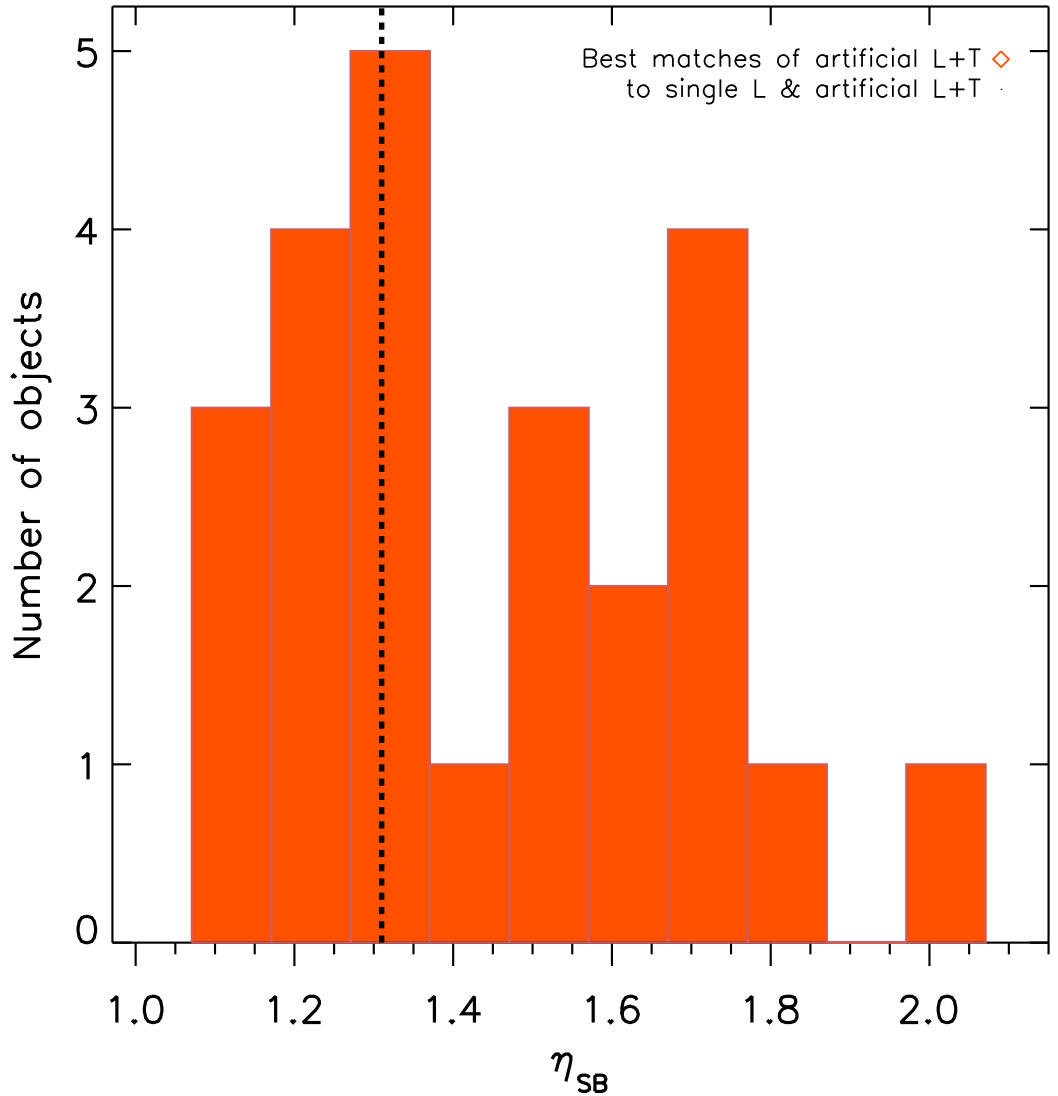

L+T

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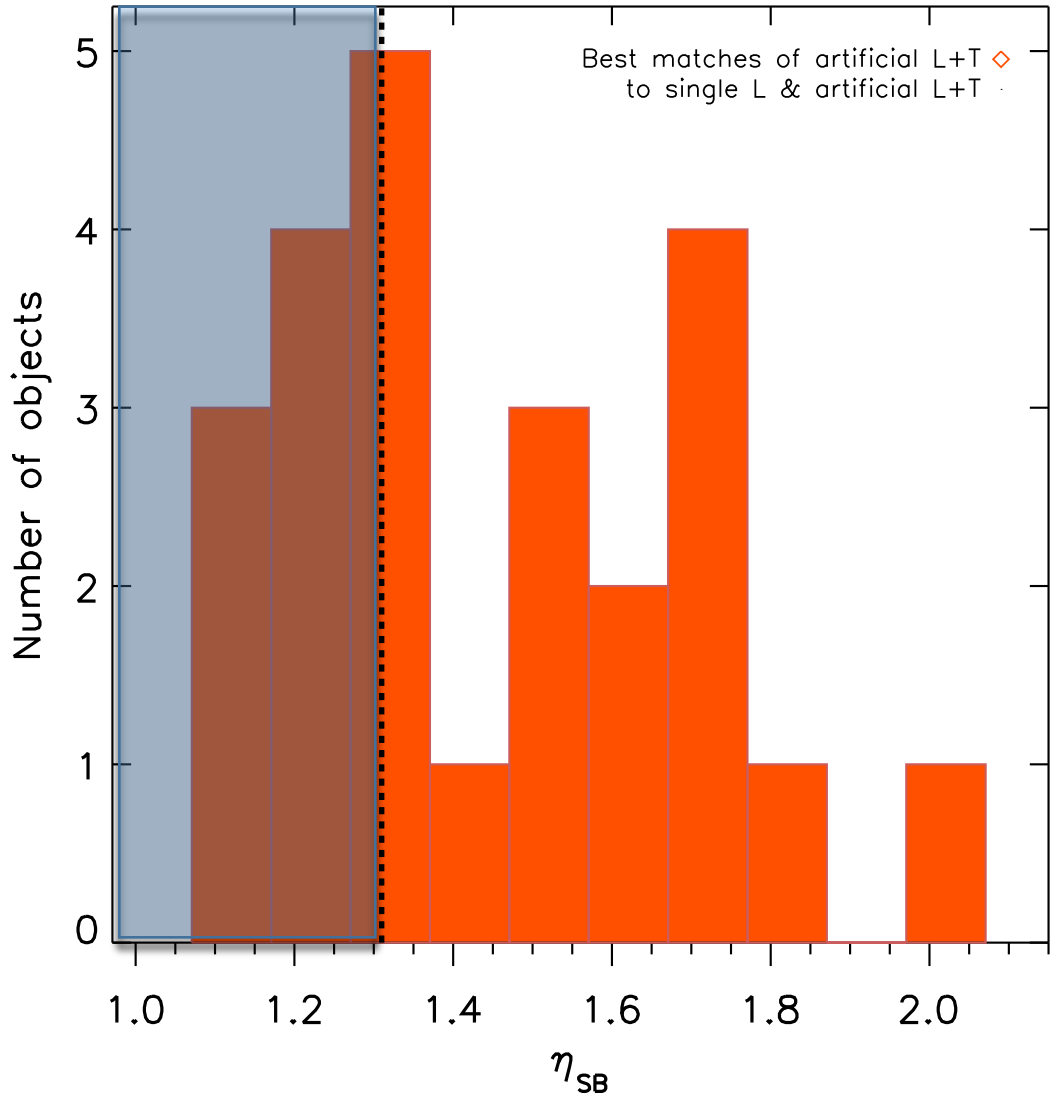
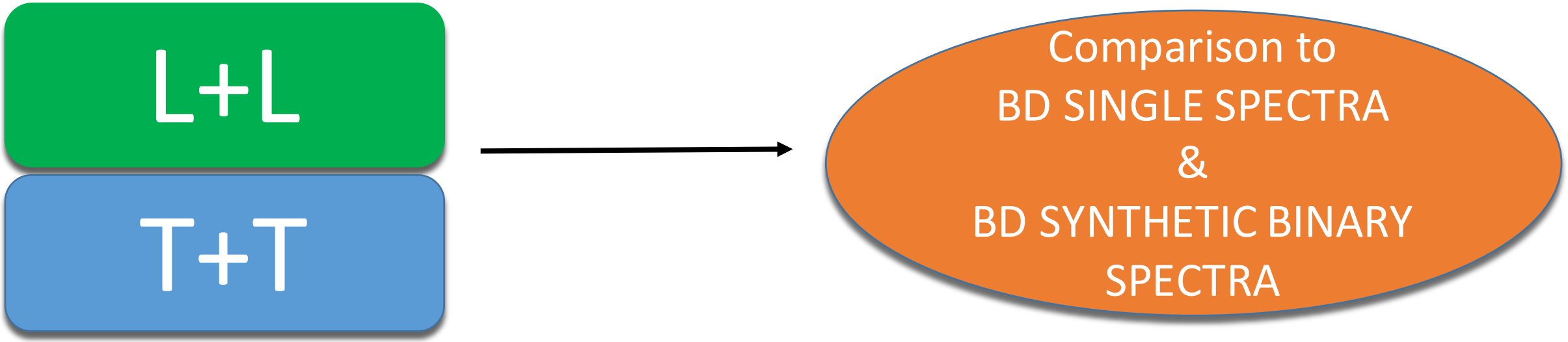


L+L

T+T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L+L

T+T

Comparison to
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SPECTRA

Can we differenciate between L & L+L spectra?

L+L

T+T

Comparison to
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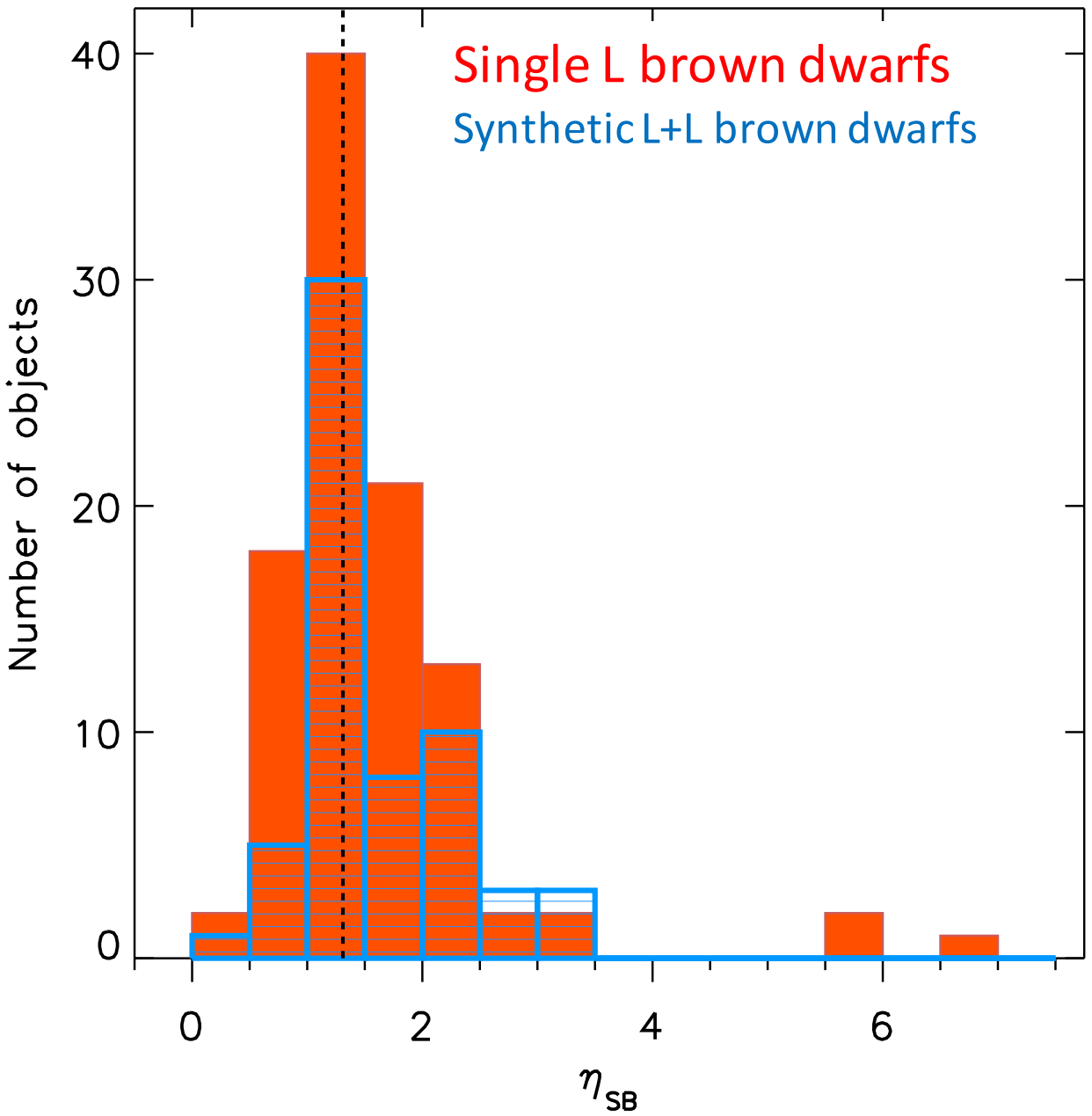
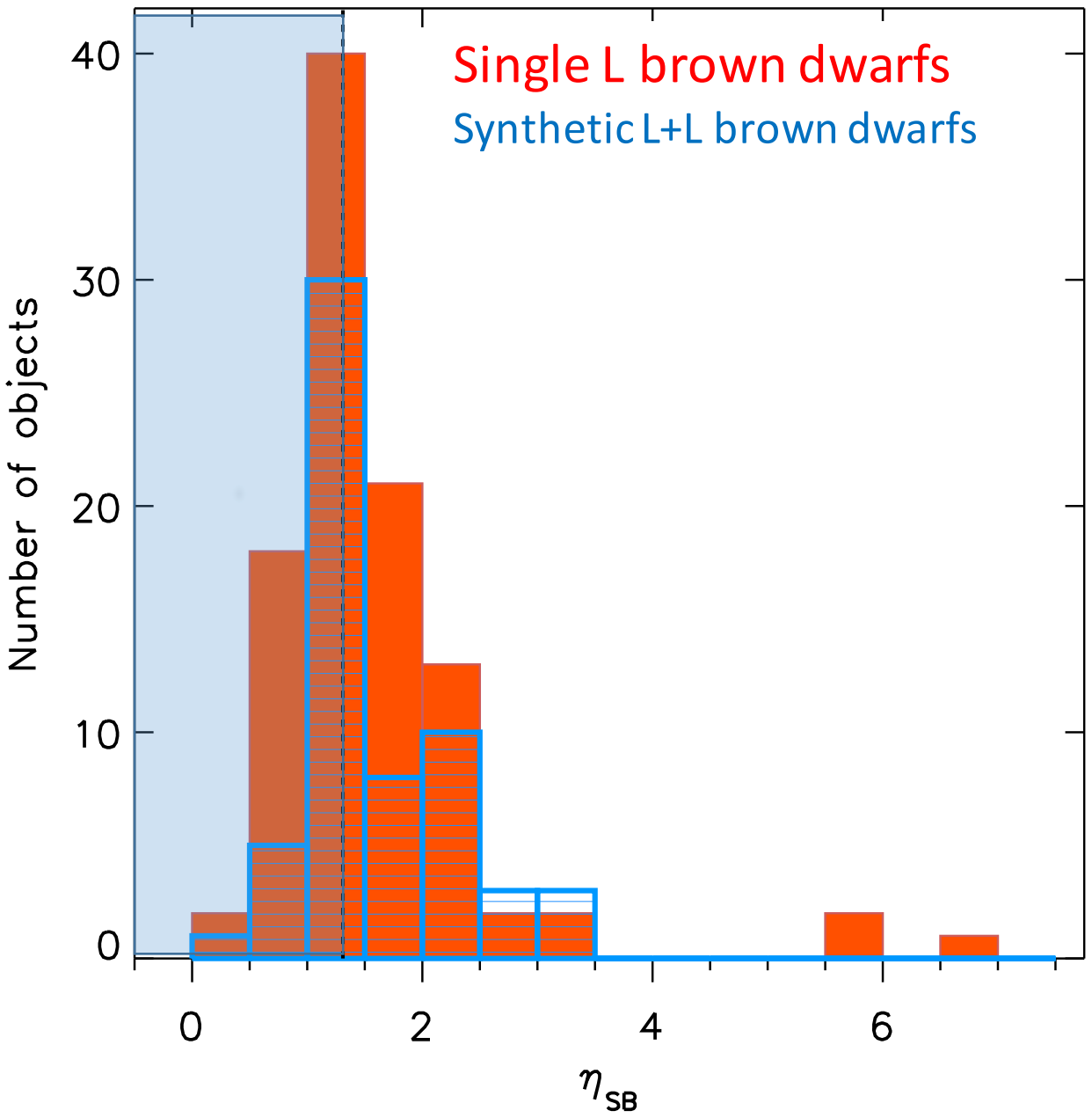
Can we differenciate between T & T+T spectra?


Single L brown dwarfs
Synthetic L+L brown dwarfs
Number of objects
40
30
20
10
0
0
2
4
6
η_{SB}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We cannot distinguish equal spectral type binaries from single BDs
(Single L & L+L binaries & T & T+T binaries)