Missing links in the evolution of massive binaries

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Fiesta del Hada de la Montaña
Bariloche – Argentina – November 2018
Speaker missed linking the evolution of massive binaries

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Let’s go!!
Sana et al. (2012): binary interaction dominates the evolution of massive stars. Sample: 70 stars, 40 SBs.
Sample: 70 stars, 40 SBs, compared with OWN (205 stars)
Complete sample OWN + published: 222 SBs
OWN + published: sample of 60 O I-II binaries, and 119 O IV-V binaries
Ratio of number of binaries (North / South)
### O stars SB status versus Luminosity

All sky (411 stars, 205 OWN)

<table>
<thead>
<tr>
<th>Status</th>
<th>I/ia/b</th>
<th>II</th>
<th>III</th>
<th>IV-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Single&quot;</td>
<td>57</td>
<td>22</td>
<td>24</td>
<td>73</td>
</tr>
<tr>
<td>SB1</td>
<td>24</td>
<td>6</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>SB2</td>
<td>18</td>
<td>4</td>
<td>29</td>
<td>53</td>
</tr>
<tr>
<td>SB3</td>
<td>5</td>
<td>3</td>
<td>11</td>
<td>20</td>
</tr>
</tbody>
</table>
**SB status versus Luminosity**

**All sky O-stars (411 stars, 205 OWN)**

<table>
<thead>
<tr>
<th>Status</th>
<th>I/la/b</th>
<th>II</th>
<th>III</th>
<th>IV-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Single”</td>
<td>0.55</td>
<td>0.63</td>
<td>0.31</td>
<td>0.40</td>
</tr>
<tr>
<td>SB1</td>
<td>0.23</td>
<td>0.17</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>SB2</td>
<td>0.17</td>
<td>0.11</td>
<td>0.37</td>
<td>0.29</td>
</tr>
<tr>
<td>SB3</td>
<td>0.05</td>
<td>0.09</td>
<td>0.14</td>
<td>0.11</td>
</tr>
</tbody>
</table>

- Multiplicity status in early B-type supergiants is unknown: ~1000 stars collected from databases and only 60 SBs!
### SB status in late O-type and early B-type supergiants

<table>
<thead>
<tr>
<th>Star Type</th>
<th>Number</th>
<th>SB Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>O7</td>
<td>11 / 20</td>
<td>0.57</td>
</tr>
<tr>
<td>O8</td>
<td>9 / 19</td>
<td>0.52</td>
</tr>
<tr>
<td>O9</td>
<td>24 / 63</td>
<td>0.38</td>
</tr>
<tr>
<td>B0</td>
<td>11 / 260</td>
<td>0.04</td>
</tr>
</tbody>
</table>

- The low binary numbers of SBs in early-B supergiants:
- Is an observational bias?,
- Or due to binary mergers, or disrupted binaries?
HRD → Martins & Palacios (2013)
Tracks → Ekstrom et al. (2012)
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“These are my principles; if you don’t like them, I have others.”

– Groucho Marx

And remember: If your principles don’t work the way you expect them, you can always create new ones.
“These are my observations if you don’t like them, I have others.”

— Groucho Marx

And remember: If your models don’t work the way you expect them, you can always create new ones.
You can only confirm that a massive star is a binary, but never that it is not.

Virpi Niemelä
Yo digo que las estrellas
Le dan gracias a la noche
Porque encima de otro coche
No pueden lucir tan bellas
Y digo que es culpa de ella
De la noche, el universo,
Cual son culpables los versos
De que haya noches y estrellas.

Silvio Rodríguez

I say that stars
Thank the night
Because on top of another car
They cannot look so beautiful
And, I say it's her fault
of the night, the universe,
what are the guilty verses
that there are nights and stars.
That's all folk!!