and the equations of condition

\[
\delta x'' = + \nu \sin f \cos (F + \ell) \cdot \kappa \delta I_0,
\]

\[
- \nu \sin f \cos (F + \ell) \cos l + \cos F, \cdot a_0 \cdot \sin (Q + N)
\]

\[
+ \nu \sin f \cos (F + \ell) \sin l - \sin F, \cdot a_0 \cdot \cos (Q + N)
\]

\[
+ \nu \tan \frac{J}{Q} \cos (l - N + a - N) \cdot a_0 \left( \sin J + \frac{\delta J}{\omega} \right) \sin \delta N
\]

\[
+ \nu \sin (l - N) \cos f \cdot a_0 \left[ \sin \left( J + \frac{\delta J}{\omega} \right) \cos \delta N - \sin J \right]
\]

\[
+ \frac{x''}{a_0} \cdot \delta a_0
\]

\[
\delta y'' = + \nu \sin g \cos (G + \ell) \cdot \kappa \delta I_0,
\]

\[
- \nu \sin g \cos (G + \ell) \cos l + \cos G, \cdot a_0 \cdot \sin (Q + N)
\]

\[
+ \nu \sin g \cos (G + \ell) \sin l - \sin G, \cdot a_0 \cdot \cos (Q + N)
\]

\[
- \nu \cos (l - N) \cos \delta + \tan \frac{J}{Q} \sin (l - N + a - N) \sin \delta, \cdot a_0 \sin \left( J + \frac{\delta J}{\omega} \right) \sin \delta N
\]

\[
+ \nu \rho \sin (l - N) \cos g \cdot a_0 \sin \left( J + \frac{\delta J}{\omega} \right) \cos \delta N - \sin J
\]

\[
+ \frac{y''}{a_0} \cdot \delta a_0
\]

The auxiliary angles are found by the formulæ

\[
\sin f \sin E = + \sin J \sin (a - N) \quad \sin g \sin (G - F) = - \sin (E + \delta)
\]

\[
\sin f \cos E = + \cos J \quad \sin g \cos (G - F) = - \cos (E + \delta) \cos f
\]

\[
\cos f = - \sin J \cos (a - N) \quad \cos g = + \cos (E + \delta) \sin f
\]

\[
\sin f \sin F = - \sin (a - N) \quad \sin f \cos F = + \cos (a - N) \cos J
\]

or \( F - N \) by

\[
\sin (F - N + a) = \tan \frac{J}{Q} \cos (a - N) \cdot \sin E.
\]

The values of \( B \) and \( P \) used in the formulæ for polar-coordinates are

\[
\cos B \sin P = - \cos (a - N) \sin J = \cos f
\]

\[
\cos B \cos P = + \cos (E + \delta) \sin f = \cos g
\]

\[
\sin B = - \sin (E + \delta) \sin f
\]

---

On the Orbit of O\( \Sigma \) 400. By J. E. Gore.

Some measures of this close binary star, made in 1885 with the 23-inch Refractor of the Princeton (U.S.A.) Observatory, and kindly sent me by Professor Young, show that the companion has described about 190° of its apparent ellipse since its discovery by O. Struve in 1844.

I have computed the orbit, and find the following provisional elements:

**Elements of O\( \Sigma \) 400.**

\[
P = 170'37'\quad \text{years} \quad \Omega = 146°\quad 20'
\]

\[
T = 1882'09' \quad \lambda = 43°\quad 30'
\]

\[
\varepsilon = 0'669 \quad a = 0'59
\]

\[
\gamma = 36°\quad 58' \quad \mu = -2°\quad 113
\]

The following table shows a comparison between these elements, and the observations used in the calculation of the orbit:
<table>
<thead>
<tr>
<th>Epoch</th>
<th>Observer</th>
<th>$\theta_a$</th>
<th>$\theta_c$</th>
<th>$\theta_a - \theta_c$</th>
<th>$\rho_a$</th>
<th>$\rho_c$</th>
<th>$\rho_a - \rho_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1844.83</td>
<td>O. Struve</td>
<td>336.9</td>
<td>335.23</td>
<td>+ 1.67</td>
<td>0.65</td>
<td>0.74</td>
<td>- 0.09</td>
</tr>
<tr>
<td>1845.69</td>
<td></td>
<td>334.7</td>
<td>334.57</td>
<td>+ 0.13</td>
<td>0.67</td>
<td>0.73</td>
<td>- 0.06</td>
</tr>
<tr>
<td>1846.68</td>
<td></td>
<td>333.1</td>
<td>333.73</td>
<td>- 0.63</td>
<td>0.60</td>
<td>0.72</td>
<td>- 0.12</td>
</tr>
<tr>
<td>1851.81</td>
<td></td>
<td>328.8</td>
<td>329.32</td>
<td>- 0.52</td>
<td>0.56</td>
<td>0.67</td>
<td>- 0.11</td>
</tr>
<tr>
<td>1853.23</td>
<td></td>
<td>324.6</td>
<td>327.70</td>
<td>- 3.10</td>
<td>0.59</td>
<td>0.65</td>
<td>- 0.06</td>
</tr>
<tr>
<td>1853.89</td>
<td>Davis</td>
<td>320.55</td>
<td>327.00</td>
<td>- 6.45</td>
<td>0.65</td>
<td>0.64</td>
<td>+ 0.01</td>
</tr>
<tr>
<td>1854.69</td>
<td>O. Struve</td>
<td>320.5</td>
<td>326.17</td>
<td>- 5.67</td>
<td>0.62</td>
<td>0.63</td>
<td>+ 0.01</td>
</tr>
<tr>
<td>1858.59</td>
<td></td>
<td>320.6</td>
<td>321.53</td>
<td>- 0.93</td>
<td>0.62</td>
<td>0.57</td>
<td>+ 0.05</td>
</tr>
<tr>
<td>1860.10</td>
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<td>319.3</td>
<td>319.40</td>
<td>- 0.10</td>
<td>0.62</td>
<td>0.55</td>
<td>+ 0.07</td>
</tr>
<tr>
<td>1861.62</td>
<td></td>
<td>318.1</td>
<td>317.13</td>
<td>+ 0.97</td>
<td>0.62</td>
<td>0.53</td>
<td>+ 0.09</td>
</tr>
<tr>
<td>1865.51</td>
<td>Dembowski</td>
<td>311.2</td>
<td>310.0</td>
<td>+ 1.20</td>
<td>&quot;difficilissima&quot;</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>1865.94</td>
<td></td>
<td>310.3</td>
<td>309.06</td>
<td>+ 1.24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1868.55</td>
<td></td>
<td>301.6</td>
<td>302.50</td>
<td>- 0.90</td>
<td>&quot;difficile&quot; &quot;cert. oblunga&quot;</td>
<td>0.39</td>
<td></td>
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<tr>
<td>1870.51</td>
<td></td>
<td>302.0</td>
<td>296.27</td>
<td>+ 5.73</td>
<td>&quot;difficilissima&quot;</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>1871.57</td>
<td></td>
<td>300.4</td>
<td>292.1</td>
<td>+ 8.30</td>
<td>&quot;ovale&quot;</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>1872.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>1873.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>1874.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>1875.67</td>
<td>Schiaparelli</td>
<td>287.8</td>
<td>280.2</td>
<td>+ 9.10</td>
<td>&quot;oblunga?&quot; &quot;molta incerta&quot;</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>1877.59</td>
<td>Dembowski</td>
<td>287.8</td>
<td>276.3</td>
<td>+ 11.5</td>
<td>&quot;oblunga?&quot;</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>1878.64</td>
<td>Burnham</td>
<td>267.9</td>
<td>267.70</td>
<td>+ 0.20</td>
<td>0.33</td>
<td>0.23</td>
<td>+ 0.10</td>
</tr>
<tr>
<td>1885.715</td>
<td>Young</td>
<td>149.5</td>
<td>143.0</td>
<td>+ 6.5</td>
<td>0.3 &quot;est&quot;</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>1885.731</td>
<td></td>
<td>139.5</td>
<td>143.0</td>
<td>- 3.5</td>
<td>&gt; 0.25</td>
<td>0.23</td>
<td>&gt; + 0.02</td>
</tr>
</tbody>
</table>
Considering that the errors in the measures of so close a pair
are necessarily considerable, the above comparison may be con-
sidered as fairly satisfactory.

The position of the binary is for 1880—

R.A. 20° 6' 14''
+ 43° 35'

Magnitudes, 7.3, 7.7, according to Burnham.


The following catalogue is the outcome of many hundreds of
observations, extending over (more particularly) a period of
about seventeen years (1870–86), though not a few of the stars
were examined in an unmethodical fashion during several years
previous to 1870. Between 1870 and 1881 the telescope em-
ployed was a 4-inch Refractor by Cooke, but all the observations
since 1884 have been made with a 6-inch Refractor by Grubb,
almost always charged with an eyepiece of very low power,
having a field of 14°. The observations of colour cited with the
name "Brodie" appended were made by my cousin, Mr. C. G.
Brodie, of Fernhill, I.W., with an 8½-inch Refractor, in the years
1884–86. He has seen most of the stars which I have observed,
but I have quoted from his notes only, as a rule, in cases where
we did not agree in our estimates of colour.

The existing catalogues of red stars from which contribu-
tions have been levied are the following: but I have not limited
myself to these, having been in the habit for many years past of
making notes of all red stars wheresoever mentioned:—

  (Connaissances des Temps, An. xv. p. 378.)
1822. De Zach, Baron. Étoiles Rouges.
  (Corresp. Ast. vol. vii. p. 298.)
1847. Herschel, Sir J. Ruby-coloured, or very Intense Red
  Stars.
  (Cape Observations, p. 448.)
1866. Schjellerup, H. C. Catalog der rothen, isolirten Sterne.
  (Ast. Nach. vol. lxvii. No. 1591, June 18, 1866;
   Addenda, vol. lxviii. No. 1613, October 30, 1866.)
  (Ast. Nach. vol. lxxx. No. 1902, September 5, 1872.)
1874. Schjellerup, H. C. Zweiter Catalog der rothen, iso-
  lirten Sterne.
  (Vierteljahrschrift der Astronomischen Gesellschaft,
   vol. ix.)
  (Month. Not. vol. xxxvi. p. 331, 1876.)
  (Trans. Roy. Irish Acad. vol. xxvi. p. 249, 1877.)
  (Ast. Nach. vol. lxxxix. No. 2121, March 27, 1877.)