RC J0311+0507: A Candidate to Superpowerful Radio Galaxies with $z = 4.514$

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Abstract. The investigations of the ultra steep spectrum radio source RC J0311+0507 (4C+04.11) in radio (RATAN-600, VLA) and optics (6-m telescope SAO RAS) are presented. The identification of a strong line at 6703 Å with Ly$\alpha$ gives a redshift $z=4.514$. The object belongs to the group of extremely distant radio galaxies of ultrahigh radio luminosity ($P_{1400} = 1.3 \times 10^{29} \text{ WHz}^{-1}$).

Keywords. high-redshift galaxies, cosmological parameters, early universe

The radio source RC J0311+0507 was discovered in 1980-1981 during the first deep survey with RATAN-600 multi-frequency complex. Figure 1a shows the superposition of the 4860-MHz isophotal image of this source on the R-band 6-m telescope (SAO RAS) image of the host galaxy. A strong emission line at 6703 Å has been detected in the optical spectrum for the host galaxy (R = 23.1) with 6-m telescope in 2004 (Fig. 1b). We identified narrow intense line at the center with Ly$\alpha$ at redshift $z = 4.514$. The data for known galaxies at $z > 4$ are given in table 1. Such high power can be provided only by a super massive black hole ($\sim 10^9 M_\odot$) that formed in a time less than the age of Universe at the observed $z$ (1.3 Gyr) or had a primordial origin.

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Table 1. Data for radio galaxies at $z > 4$

<table>
<thead>
<tr>
<th>Name</th>
<th>$z$</th>
<th>$m_{opt}$</th>
<th>$m_k$</th>
<th>$S_{1400}$, mJy</th>
<th>$\alpha$</th>
<th>LAS</th>
<th>Morphology</th>
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<tbody>
<tr>
<td>TN J0924-2201</td>
<td>5.199</td>
<td>$&gt;$24</td>
<td>R</td>
<td>21.7</td>
<td>71</td>
<td>1.65</td>
<td>1”2</td>
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<tr>
<td>RC J0311+0507</td>
<td>4.514</td>
<td>23.1</td>
<td>R</td>
<td>...</td>
<td>500</td>
<td>1.29</td>
<td>2.8</td>
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<tr>
<td>VLA J123642+621331</td>
<td>4.424</td>
<td>24.9</td>
<td>I</td>
<td>21.4</td>
<td>0.5</td>
<td>0.94</td>
<td>0.4</td>
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<tr>
<td>6C 0140+326</td>
<td>4.413</td>
<td>24</td>
<td>I</td>
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<td>91</td>
<td>1.17</td>
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<td>8C 1435+63</td>
<td>4.261</td>
<td>23.6</td>
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<td>19.5</td>
<td>497</td>
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<td>TN J123-2154</td>
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<td>R</td>
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<td>236</td>
<td>1.08</td>
<td>18.</td>
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