

# *The Blazar Times*

A Research Newsletter Dedicated to the BL Lac and Blazar Phenomena

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Editor: Travis A. Rector (blazar@uaa.alaska.edu)

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### *Journal Abstracts*

#### **The WEBT BL Lacertae Campaign 2001 and its extension. Optical light curves and colour analysis 1994–2002**

M. Villata<sup>1</sup>, C. M. Raiteri<sup>1</sup>, O. M. Kurtanidze<sup>2,3,4</sup>, M. G. Nikolashvili<sup>2</sup>, M. A. Ibrahimov<sup>5</sup>, I. E. Papadakis<sup>6,7</sup>, G. Tosti<sup>8</sup>, F. Hroch<sup>9</sup>, L. O. Takalo<sup>10</sup>, A. Sillanpää<sup>10</sup>, V. A. Hagen-Thorn<sup>11,12</sup>, V. M. Larionov<sup>11,12</sup>, R. D. Schwartz<sup>13</sup>, J. Basler<sup>13</sup>, L. F. Brown<sup>14</sup>, T. J. Balonek<sup>15</sup>, E. Benítez<sup>16</sup>, A. Ramírez<sup>16</sup>, A. C. Sadun<sup>17</sup>, P. Boltwood<sup>18</sup>, M. T. Carini<sup>19</sup>, D. Barnaby<sup>19</sup>, J. M. Coloma<sup>20</sup>, J. A. Ros<sup>20</sup>, B. Z. Dai<sup>21,22,23</sup>, G. Z. Xie<sup>21,22,23</sup>, J. R. Mattox<sup>24</sup>, D. Rodriguez<sup>25</sup>, I. M. Asfandiyarov<sup>5</sup>, A. Atkerson<sup>19</sup>, J. L. Beem<sup>14</sup>, S. D. Bloom<sup>26</sup>, S. M. Chanturiya<sup>2</sup>, S. Ciprini<sup>8</sup>, S. Crapanzano<sup>1</sup>, J. A. de Diego<sup>16</sup>, N. V. Efimova<sup>11</sup>, D. Gardiol<sup>1,27</sup>, J. C. Guerra<sup>27</sup>, B. B. Kahharov<sup>5</sup>, B. Z. Kapanadze<sup>2</sup>, H. Karttunen<sup>10</sup>, T. Kato<sup>28</sup>, G. N. Kimeridze<sup>2</sup>, N. A. Kudryavtseva<sup>11</sup>, M. Lainela<sup>10</sup>, L. Lanteri<sup>1</sup>, E. G. Larionova<sup>11</sup>, M. Maesano<sup>29</sup>, N. Marchili<sup>8</sup>, G. Massone<sup>1</sup>, T. Monroe<sup>19</sup>, F. Montagni<sup>30</sup>, R. Nesci<sup>31</sup>, K. Nilsson<sup>10</sup>, J. C. Noble<sup>32</sup>, G. Nucciarelli<sup>8</sup>, L. Ostorero<sup>4,33</sup>, J. Papamastorakis<sup>7,6</sup>, M. Pasanen<sup>10</sup>, C. S. Peters<sup>14</sup>, T. Pursimo<sup>34</sup>, P. Reig<sup>35,6</sup>, W. Ryle<sup>19</sup>, S. Sclavi<sup>31</sup>, L. A. Sigua<sup>2</sup>, M. Uemura<sup>28</sup> and W. Wills<sup>19</sup>

<sup>1</sup> Istituto Nazionale di Astrofisica (INAF), Osservatorio Astronomico di Torino, Via Osservatorio 20, 10025 Pino Torinese (TO), Italy

<sup>2</sup> Abastumani Astrophysical Observatory, 383762 Abastumani, Georgia

<sup>3</sup> Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany

<sup>4</sup> Landessternwarte Heidelberg-Königstuhl, Königstuhl 12, 69117 Heidelberg, Germany

<sup>5</sup> Ulugh Beg Astronomical Institute, Academy of Sciences of Uzbekistan, 33 Astronomical Str., Tashkent 700052, Uzbekistan

<sup>6</sup> IESL, FORTH, 711 10 Heraklion, Crete, Greece

<sup>7</sup> Physics Department, University of Crete, PO Box 2208, 710 03 Heraklion, Crete, Greece

<sup>8</sup> Dipartimento di Fisica, Università di Perugia, Via A. Pascoli, 06123 Perugia, Italy

<sup>9</sup> Institute of Theoretical Physics and Astrophysics, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

<sup>10</sup> Tuorla Observatory, 21500 Piikkiö, Finland

<sup>11</sup> Astronomical Institute, St.-Petersburg State University, Universitetsky Pr. 28, Petrodvoretz, 198504 St.-Petersburg, Russia

<sup>12</sup> Isaac Newton Institute of Chile, St.-Petersburg Branch

<sup>13</sup> Department of Physics and Astronomy, University of Missouri-St. Louis, 8001 Natural Bridge Road, St. Louis, MO 63121, USA

<sup>14</sup> Department of Physics, Astronomy and Geophysics, Connecticut College, New London, CT 06320, USA

- <sup>15</sup> Foggy Bottom Observatory, Colgate University, 13 Oak Drive, Hamilton, NY 13346, USA
- <sup>16</sup> Instituto de Astronomía, UNAM, Apdo. Postal 70-264, 04510 México DF, Mexico
- <sup>17</sup> Department of Physics, University of Colorado at Denver, PO Box 173364, Denver, CO 80217-3364, USA
- <sup>18</sup> Boltwood Observatory, 1655 Main Street, Stittsville, Ontario K2S 1N6, Canada
- <sup>19</sup> Department of Physics and Astronomy, Western Kentucky University, 1 Big Red Way, Bowling Green, KY 42104, USA
- <sup>20</sup> Agrupació Astronòmica de Sabadell, PO Box 50, 08200 Sabadell, Spain
- <sup>21</sup> Yunnan Observatory, National Astronomical Observatories, Chinese Academy of Sciences, PO Box 110, Kunming 650011, China
- <sup>22</sup> United Laboratory of Optical Astronomy, Chinese Academy of Sciences, Beijing, China
- <sup>23</sup> Yunnan Astrophysics Center, Yunnan University, Kunming 650091, China
- <sup>24</sup> Department of Natural Sciences, Fayetteville State University, 1200 Murchison Road, Fayetteville, NC 28301, USA
- <sup>25</sup> Guadarrama Observatory, C/ San Pablo 5, Villalba 28409, Madrid, Spain
- <sup>26</sup> Department of Physics and Astronomy, Hampden-Sydney College, Hampden-Sydney, VA 23943, USA
- <sup>27</sup> Istituto Nazionale di Astrofisica (INAF), Telescopio Nazionale Galileo, Roque de los Muchachos Astronomical Observatory, PO Box 565, 38700 Santa Cruz de La Palma, TF, Spain
- <sup>28</sup> Department of Astronomy, Faculty of Science, Kyoto University, Kyoto, Japan
- <sup>29</sup> Stazione Astronomica Vallinfreda, Italy
- <sup>30</sup> Stazione Astronomica Greve in Chianti, Italy
- <sup>31</sup> Dipartimento di Fisica, Università La Sapienza, Piazzale A. Moro 2, 00185 Roma, Italy
- <sup>32</sup> Institute for Astrophysical Research, Boston University, 725 Commonwealth Ave., Boston, MA 02215, USA
- <sup>33</sup> Dipartimento di Fisica Generale, Università di Torino, Via P. Giuria 1, 10125 Torino, Italy
- <sup>34</sup> Nordic Optical Telescope, Roque de los Muchachos Astronomical Observatory, PO Box 474, 38700 Santa Cruz de La Palma, TF, Spain
- <sup>35</sup> G.A.C.E., Departament d’Astronomia i Astrofísica, Universitat de València, 46071 Paterna-València, Spain

BL Lacertae has been the target of four observing campaigns by the Whole Earth Blazar Telescope (WEBT) collaboration. In this paper we present *UBVRI* light curves obtained by the WEBT from 1994 to 2002, including the last, extended BL Lac 2001 campaign. A total of about 7500 optical observations performed by 31 telescopes from Japan to Mexico have been collected, to be added to the  $\sim 15600$  observations of the BL Lac Campaign 2000. All these data allow one to follow the source optical emission behaviour with unprecedented detail. The analysis of the colour indices reveals that the flux variability can be interpreted in terms of two components: longer-term variations occurring on a few-day time scale appear as mildly-chromatic events, while a strong bluer-when-brighter chromatism characterizes very fast (intraday) flares. By decoupling the two components, we quantify the degree of chromatism inferring that longer-term flux changes imply moving along a  $\sim 0.1$  bluer-when-brighter slope in the  $B - R$  versus  $R$  plane; a steeper slope of  $\sim 0.4$  would distinguish the shorter-term variations. This means that, when considering the long-term trend, the  $B$ -band flux level is related to the  $R$ -band one according to a power law of index  $\sim 1.1$ . Doppler factor variations on a “convex” spectrum could be the mechanism accounting for both the long-term variations and their slight chromatism.

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For preprints contact: [villata@to.astro.it](mailto:villata@to.astro.it)

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## Sub-millisecond Imaging of Quasars and Active Galactic Nuclei III. Kinematics of Parsec-Scale Radio Jets

**K. I. Kellermann<sup>1</sup>, M. L. Lister<sup>1,2</sup>, D. C. Homan<sup>1,3</sup>, R. C. Vermeulen<sup>4</sup>, M. H. Cohen<sup>5</sup>, E. Ros<sup>6</sup>, M. Kadler<sup>6</sup>, J. A. Zensus<sup>6,1</sup>, Y. Y. Kovalev<sup>7,8</sup>**

<sup>1</sup> National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903–2475, U.S.A.

<sup>2</sup> Department of Physics, Purdue University, 525 Northwestern Avenue, West Lafayette, IN 47907, U.S.A.

<sup>3</sup> Department of Physics and Astronomy, Denison University, Granville, OH 43023, U.S.A.

<sup>4</sup> ASTRON, Postbus 2, NL-7990 AA Dwingeloo, Netherlands

<sup>5</sup> Department of Astronomy, Mail Stop 105-24, California Institute of Technology, Pasadena, CA 91125, U.S.A.

<sup>6</sup> Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany

<sup>7</sup> National Radio Astronomy Observatory, P.O. Box 2, Green Bank, WV 24944, U.S.A.

<sup>8</sup> Astro Space Center of P.N. Lebedev Physical Institute, Profsoyuznaya 84/32, 117997 Moscow, Russia

We report the results of a 15 GHz (2 cm) multi-epoch VLBA program, begun in 1994 to study the outflow in radio jets ejected from quasars and active galaxies. The observed flow of 208 distinct features measured in 110 quasars, active galaxies, and BL Lac objects shows highly collimated relativistic motion with apparent transverse velocities typically between zero and about  $15c$ , with a tail extending up to about  $34c$ . Within individual jets, different features appear to move with a similar characteristic velocity which may represent an underlying continuous jet flow, but we also see some stationary and even apparently inward moving features which co-exist with the main features. Comparison of our observations with published data at other wavelengths suggests that there is a systematic decrease in apparent velocity with increasing wavelength, probably because the observations at different wavelengths sample different parts of the jet structure.

The observed distribution of linear velocities is not consistent with any simple ballistic model. Either there is a rather broad range of Lorentz factors, a significant difference between the velocity of the bulk relativistic flow and the pattern speed of underlying shocks, or a combination of these options. Assuming a ballistic flow, comparison of observed apparent velocities and Doppler factors computed from the time scale of flux density variations is consistent with a steep power law distribution of intrinsic Lorentz factors, an isotropic distribution of orientations of the parent population, and intrinsic brightness temperatures about an order of magnitude below the canonical inverse Compton limit. It appears that the parent population of radio jets is not dominated by highly relativistic flows, and contrary to the assumption of simple unified models, not all sources have intrinsic speeds close to  $c$ .

Usually, the observed jet flow is in the general direction of an established jet. However, many jets show significant bends and twists, where the observed motions are non-radial, but are aligned with the local jet direction suggesting that the jet flow occurs along pre-existing bent channels. In a few cases we have observed a clear change in the direction of a feature as it flows along the jet. Radio jets which are also strong gamma-ray sources detected by EGRET appear to have significantly faster speeds than the non EGRET sources, consistent with the idea that gamma ray sources have larger Doppler factors than non gamma-ray sources. Sources at high redshift have systematically lower angular speeds than low redshift jets, consistent with standard cosmologies.

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*For preprints contact:* [kkellerm@nrao.edu](mailto:kkellerm@nrao.edu)

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## *Abstract Guidelines*

Abstracts for “The Blazar Times” are solicited for papers that have been recently accepted for publication by a refereed journal, and for recent Ph.D. theses. Please do not submit an abstract before it has been accepted, nor after it is published. Abstracts from papers which are not refereed (e.g., conference proceedings) are not accepted.

The subject matter should pertain directly to the BL Lac and/or blazar phenomenon in general. Both observational and theoretical abstracts are appropriate. Abstracts from papers dealing with other classes of AGN will generally not be included unless they explicitly discuss their relevance to the blazar phenomenon; however exceptions to this rule will be considered.

A monthly call for abstracts will be issued and abstracts received by the last day of the month will usually appear in the following month’s newsletter. Announcements of general interest to the BL Lac and blazar communities may also be submitted for posting in the newsletter. These might include (but are not restricted to) the following: (i) *Job Openings* directed toward blazar researchers, (ii) announcements of *Upcoming Meetings*, (iii) announcements of *Upcoming Observing Campaigns* for which participation is solicited from the community at large, (iv) reviews of *New Books*, and (v) *General Announcements* that provide or request research-related information.

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