Curriculum vitae of O.S.Khovanskaya

PERSONAL DATA

Name

- Surname: Khovanskaya
- Middle name: Sergeevna
- First name: Olga

Nationality and Date of Birth

- Place of Birth: Moscow, Russia
- Present nationality: russian
- Nationality at birth: russian
- Date of birth: 1977 - April - 23
- Sex: Female

Address of Institute

- Dr. O.S. Khovanskaya, Sternberg Astronomical Institute of Moscow State University (SAI MSU), Universitetsky prospect 13, room 31
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FIELD OF INTEREST

Gravitation and cosmology.

EDUCATION

- Graduated in Applied Mathematics Department of Moscow State Aviation Institute (Moscow, Russia), completed by diploma $N^0$0873122 in mathematics in 03.01.2000.
- Ph.D in Physical Department of Moscow State University (Moscow, Russia) in astrometry in 15.05.2003, $N^0$100391. The title: "Possible observation evidences of strong gravitational fields".

SCIENTIFIC EMPLOYMENT AND ACADEMIC RESPONSIBILITY

University	Period of duty	Academic responsibilities
Moscow State Aviation Institute, Applied Mathematics Department (Moscow, Russia)	1 April 1994- 31 January 2000	student
Moscow State University, Physical Department (Moscow, Russia)	1 November 2000- 15 May 2003	post-graduate student
Moscow State University, Sternberg Astronomical Institute (Moscow, Russia)	1 September 2003 till now	junior researcher

AWARDS

- The First Place for Competition in Honor of Yu. Gagarin (Moscow, Russia, 1999)
- The John Templeton Foundation and the Peter Gruber Foundation Cosmological Prize for Young Researcher Competition at the Science & Ultimate Reality Symposium in Honor of J.A.Wheeler (Princeton, New Jersey, USA, 2002)
- The Personal Grant of Russian Foundation "INTEGRATSIYA" for special one month course in Astronomical Observatory in Naples, Italy (Moscow, Russia, 2004)
- The Personal One Year Grant of Moscow State University for young researches (Moscow, Russia, 2005)

SUMMARY OF RESEARCH

My scientific efforts are distributed in three main areas.

The first part, which was the subject of my diploma and my PhD work, was theoretical one and was dedicated to search of possible relations between modern experimental cosmology and multidimensional fundamental strings' theories. More in details, to find observed consequences of Hawking evaporation of microscopic primordial black holes (PBH) in frames of perturbative approach of 4D string gravity.

It is suspected that PBHs formed in the Universe when it was extremely dense from the strong density space-time fluctuations. None of primordial black holes have yet been spotted. In a very strong gravitational field at the expense of a quantum effects a black hole can lose its mass that is evaporated. The less mass it possesses, the more intensive evaporation process occurs. Therefore the quantum effects are most important for small black holes, that is the PBHs.

One rather mysterious problem of a modern theoretical physics has been a question about the final stage of PBHs Hawking evaporation.

It is known that superstring theories and M-theory are possible approaches to unify quantum theory and gravity. In the frames of the perturbative approach, 4D string gravity is described by the low-energy effective action. Except Einstein term this action usually includes dilaton, Yang-Mills fields and the higher order curvature corrections. Therefore new types of black hole solutions, and new types of singularities, absented in classical General Relativity, appear. Einstein equations are modified by higher order curvature corrections in the range where the curvature of space-time is rather great in compatible with Planck value.

One of the most important result of this work was the determination of the restriction on the PBH mass and time stability of such remnant. Such restriction appears in high order curvature gravity in 4D string gravity and is absent in the Einstein gravity.

Therefore in the frames of string theory the possibility that PBHs are not evaporated completely, exists. In this case some primordial remnant remains. If these remnants exist they can form a part of a dark matter in the Universe and can be detected by their decaying into high energy particles (possible explanation of GZK-effect).

The second subject was more experimental and connected with Cosmic Microwave Background Radiation (CMBR) data analysis.

The polarization of CMBR is a powerful observational tool at hand for modern cosmology. It allows to break the degeneracy of fundamental cosmological parameters one can not obtain using only anisotropy data and provides new insight into conditions existing in the very early Universe. Many experiments are now in progress whose aim is detecting anisotropy and polarization of the CMB. Measurements of the CMB polarization are however hampered by the presence of polarized foregrounds, above all the synchrotron emission of our Galaxy, whose importance increases as frequency decreases and dominates the polarized diffuse radiation at frequencies below $\simeq 50$ GHz.In the past the separation of CMB and synchrotron was made combining observations of the same area of sky at different frequencies. In this work we showed that the statistical properties of the polarized components of the synchrotron and dust foregrounds are different from the statistical properties of the polarized component of the CMB, therefore one can build a statistical estimator which allows to extract the polarized component of the CMB from single frequency data also when the polarized CMB signal is just a fraction of the total polarized signal. Our estimator improves the signal to noise ratio for the polarized component of the CMB and reduces from $\simeq 50$ GHz to $\simeq 20$ GHz the frequency above which the polarized component of the CMB can be extracted from single frequency maps of the diffuse radiation.

My present field of interest brings together the theoretical and experimental cosmology and is dedicated to search of cosmic strings, predicted by physical theories of early Universe. In details, we have to clarify the nature of very peculiar object named CSL-1 (Capodimonte-Sternberg-Lens Candidate $N^0 1$), which is probably the first case of gravitational lensing of a galaxy by cosmic string.

In modern cosmology it is supposed a complex structure of a dark matter and it is believed to consist from different types of matter which change both spectrum of primordial fluctuation and transfer function. One of the possible candidates for such type is cosmic string. Cosmic string have not never been observed yet.

By russian-italian group it was discovered and studied in details a peculiar double source CSL-1. The detailed photometry of CSL-1 shows that two extended images are well fit by de Vaucouleurs law, indicating two giant weak elliptic galaxies with absolute magnitude 22.3, linear separation about

20 Kpc, redshift 0.46. The undistorted and almost circular isophotal shapes (obtained after careful adaptive smoothing of the data and removal of the bright central regions)in all bands allow us to conclude that two system are not interacting. The absence of emission lines and the presence of the typical absorption features confirm that we are dealing with early type systems. The spectra of two components are identical with a confidence level higher than 99.9 % . The spectra have been obtained in Telescopio Nazionale Galileo (TNG, 3.58 m, Canar.Isl.) and in New Tecnology Telescope (NTT, 3.58 m, ESO, La Silla, Chile). Even in our deepest images (24.5 in R band) we cannot see any trace of a lens between our two images this implying that if CSL-1 is the product of gravitational lens, such a lens should be a dark one and do not distort the isophotes of CSL-1 extended components. We can also rule out the possibility that the peculiar morphology of CSL-1 is produced by a very unlikely strong dust lane which should have a perfectly tailored shape and, in any case could not match simultaneously the observed profiles at the various wavelenghts.

There are only two possibilities to explain the nature of CSL-1.

The first one is that we are dealing with very unlikely chance alignment of identical galaxies.

The second one is that CSL-1 has gravitational nature and it is produced by gravitational lensing of a galaxy by cosmic string.

There are two main methods to confirm or disprove the cosmic string interpretation of CSL-1.

The first one is to obtain high resolution images where to look for the sharp peculiar signatures left by the cosmic string lensing mechanism. However. the required resolution is obtainable only with long exposures with HST.

The second and more effective one is to look for an excess of gravitational lensed images along the cosmic string. The alignment of the background object inside the string deficit angle is a stochastic process determined by the area of the lensing strip and by the surface density distribution of the extragalactic objects which are laying behind the sting. All lensed objects will fall inside a narrow strip defined by the deficit angle. The process looks like a creation of a new "milky way"of galaxies. We inspected a region of the OACDF centered on CSL-1, where in the case of cosmic string scenario we expect to find a minimum of 7-9 lens candidates. This scenario seems to be supported by the fact that using very deep photometric multiband data and very strict morphological, photometric and colorimetric selection criteria we identified 11 lens candidates which now need to be confirmed by spectroscopic observations.

If we accept the interpretation of CSL-1 as a gravitational lens produced by a cosmic string, it is possible to derive the scale of energy at which the symmetry breaking occurred. The physical mechanism which produces cosmic strings is related to the phase transition in the early Universe. This phase transition took place when the temperature of the Universe fell below a critical temperature defined by some energy scale which, on the other hand, defines the unification of physical interactions and, probably, also the main parameters of the inflation.

The distance between the peaks of two images $2''$ of CSL-1 roughly corresponds to the "deficit angle"of the string as $4 \times 10^{-7} m_{Pl}^2$. We can estimate the mass scale of symmetry breaking as 2×10^{15} GeV, which is predicted by cosmic string theory and is in reasonable agreement with extrapolated accelerator data.

INTERNATIONAL ACTIVITY

- "International Conference on Gravitation and Cosmology", Moscow, Russia, 1-7 October 2001.
- "Science & Ultimate Reality Symposium in Honor of J.A.Wheeler", Princeton, New Jersey, USA, 15-18 March (2002) *Peter Gruber Prize.*
- "New Frontiers of Relic Radiation Physics", College de France, Paris, France, 25 March - 19 April (2002).
- "International School-Seminar Dark Matter, Dark Energy and Gravitational Lensing", Moscow, Russia 19-21 June (2002) *member of LOC.*
- "International School-Seminar Cosmology, Extragalactic Astronomy, and Applied Astrophysics", Zvenigorod, Russia, 1-4 March (2004) *plenary talk, secretary of LOC.*
- "Wide Field Imaging from Space Conference", Berkeley, California, USA, 16-18 May (2004).
- "QUARKS-2004", Pushkinogorie, Russia, 25-30 May (2004).

- "COSMION-2004", Moscow-San-Petersburg-Paris-Medon, Russia-France, 2-15, 20-26 September (2004) *plenary talk*.
- "22nd Texas Symposium at Stanford University", Palo Alto, California, USA, 13-17 December (2004).

and talks in:

- Zelmanov Memorial Seminar on Gravitation and Cosmology, Sternberg Astronomical Institute, Moscow, Russia, 12 February (2003).
- Universita di Napoli Federico II, Dipartimento di Scienze Fisiche, Naples, Italy, 16 November (2004).
- SETI, California, USA, 16 December (2004).

PUBLICATIONS

1. S.O.Alexeyev, O.S.Khovanskaya **Additional study of a restriction on the minimum black hole mass in string gravity** *Grav.Cosmol.* **6** (21), 14-18 (2000).
2. O.S.Khovanskaya **Black holes in higher curvature gravity** *Grav. Cosmol. Suppl* **8** (2), 67-68 (2002).
3. O.S.Khovanskaya **Dilatonic black hole time stability** *Grav.Cosmol.* **8** 197-200, (2002).
4. S.O.Alexeyev, M.V.Sazhin, O.S.Khovanskaya **Parameters of the Early Universe and Primordial Black Holes** *Astronomy Letters* **28** 3, 139-142 (2002).
5. S.O.Alexeyev, A.Barrow, G.Bowdole, M.V.Sazhin, O.S.Khovanskaya **A Simple Model for the Evaporation of Black Holes at Final Stages** *Astronomy Letters* **28** 7, 428-433 (2002).
6. S.O.Alexeyev, A.Barrow, G.Bowdole, O.S.Khovanskaya, M.V.Sazhin **Black hole relics in string gravity: last stages of Hawking evaporation** *Class. Quant.Grav.* **19** 4431-4444 (2002).

7. M.V.Sazhin, G.Sironi, O.S.Khovanskaya **Separation of foreground and background signals in single frequency measurements of the CMB polarization** *New Astronomy* **9** 2, 83-101 (2004), astro-ph/0306250.

8. M.V.Sazhin, G.Longo, M.Capaccioli, J.M. Alcala, R. Silvotti, G. Covone, O.S.Khovanskaya, M.V.Pavlov, M.Pannella, M.Radovich, V.Testa **CSL-1: chance projection effect or serendipitous discovery of a gravitational lens induced by a cosmic string?** *MNRAS* **343** 2, 353-359 (2003).

9. M.V.Sazhin, O.S.Khovanskaya, M.Capaccioli, G.Longo, J.M. Alcala, R. Silvotti, M.V. Pavlov **Search for Gravitational Lenses Near the Extragalactic Double Object CSL-1** *Astronomy Letters* **31** 2, 73-79 (2005), astro-ph/0406516.

10. O.S.Khovanskaya, M.V.Sazhin **CSL-1: projection effect** *accepted by Astron. Zhurnal* (2005) (in russian).

11. O.S.Khovanskaya, M.V.Sazhin, M.Capaccioli, G.Longo **Possible Observation of a Cosmic String** Expanded version of proceedings of the International Conference "Wide Field Imaging from Space", Berkeley, California, USA, 16-18 May, 2004 *accepted by New Astronomy Reviews* (2005).

12. M.V.Sazhin, O.S.Khovanskaya, M.Capaccioli, G.Longo **Possible Observation of a Cosmic String** Electronic proceedings of the International Conference "QUARKS-2004", Pushkinogorie, Russia, 25-30 May, 2004 *http://quarks.inr.ac.ru* (2004).

13. M.V.Sazhin, M.Capaccioli, G.Longo, O.S.Khovanskaya **CSL-1: First Evidence for Lensing by a Cosmic String?** Proceedings of the International Conference "Thinking, Observing and Mining the Universe", Sorrento, Italy, 22-27 September, 2003, edited by G. Miele, G. Longo *World Scientific Publishing Co.Pte.Ltd.* 265-271 (2004).

14. M.V.Sazhin, O.S.Khovanskaya, M.Capaccioli, G.Longo **Possible Observation of a Cosmic String** Proceedings of the International Conference "COSMION-2004", Moscow - San-Petersburg - Paris - Medon, Russia - France, 2-15, 20-26 September (2004).

15. E.V.Ivanova, O.S.Khovanskaya **Effective curvature of the Universe under observations of remote objects** *submitted to Pis'ma v Astron. Zhurnal* (2005) (in russian).

16. O.S.Khovanskaya, M.V.Sazhin, M.Capaccioli, G.Longo **Possible Observation of a Cosmic String** Proceedings of the International Conference "22nd Texas Symposium at Stanford University", Palo Alto, California, USA, 13-17 December, 2004 *SLAC Electronic Conference Proceedings Archive, http://www.slac.stanford.edu/econf, in press* (2005).