CURRICULUM VITAE

PERSONAL INFORMATION

Name:	Krešimir JAKOVČIĆ
Date and place of birth:	8th October 1973 in Zagreb (Croatia)
Citizenship:	Croatian
Gender:	male
Professional address:	Ruđer Bošković Institute Bijenička cesta 54, 10000 Zagreb, Croatia
Phone (office):	+ 385 1 456 0957
Fax:	+ 385 1 468 0239
E-mail:	Kresimir.Jakovcic@irb.hr
Languages:	Croatian (mother tongue) English (proficient user) German (basic)

EDUCATION

University of Zagreb, Faculty of Science, Department of Physics: Ph.D., May 2008
Thesis title: "Search for 14.4 keV Axions Using CERN Axion Solar Telescope"
Thesis advisor: Dr. Milica Krčmar

University of Zagreb, Faculty of Science, Department of Physics: M.Sc., June 2004
Thesis title: "Search for Solar Axions Using ^{83}Kr"
Thesis advisor: Dr. Ante Ljubičić

University of Zagreb, Faculty of Science, Department of Physics: B.Sc., June 1999
Thesis title: "Determination of the CKM-matrix Angles from the B Meson Decays"
Thesis advisor: Prof. Dr. Ivica Picek

High school "Matematičko informatički obrazovni centar (MIOC)", Zagreb:
High school diploma, June 1992

Elementary school, Zagreb, 1980-1988

WORK EXPERIENCE / POSITIONS

May 2011 -	Research associate at the Division of Experimental Physics at the Ruđer Bošković Institute in Zagreb (Croatia)
June 2008 – May 2011	Senior research assistant at the Division of Experimental Physics at the Ruđer Bošković Institute in Zagreb (Croatia)
October 1999 – June 2008	Research assistant at the Division of Experimental Physics at the Ruđer Bošković Institute in Zagreb (Croatia)

PARTICIPATION IN SCIENTIFIC PROJECTS

a) Scientific projects of the Croatian Ministry of Science, Education and Sport :
   - 00980204 : "Elementary Particle Physics Beyond Standard Model" (1999 – 2000)
   - 0098011 : "Massive Neutrinos and Astroparticles" (2000 – 2006)
   - 098-0982887-2872 : "Massive Neutrinos and Astroparticles: From Particle Physics to Cosmology" (2007 –)
   - "Remote Control and Monitoring of the Scientific Experiment Using Mobile Phone and/or Internet" (project ID: 2002-007, contact no. 353-01-10-2002) (2002 – 2003)

b) Since 2000, member of the OPERA experiment (Oscillation Project with Emulsion Tracking Apparatus) conducted at CERN (European Organization for Nuclear Research, Switzerland) and LNGS (Laboratori Nazionali del Gran Sasso, Italy)

c) Since 2004, member of the CAST experiment (CERN Axion Solar Telescope) conducted at CERN (European Organization for Nuclear Research, Switzerland)

FIELD OF RESEARCH

1) <u>Solar axions</u>

Axions are hypothetical neutral pseudoscalar particles that arise in the context of the Peccei-Quinn solution to the strong CP problem. They are also viable dark matter candidates. It is expected that axions and similar axion-like particles could be copiously produced by nuclear and thermal processes in stars. Hence, the Sun would be a powerful source of these particles. So far, my search for solar axions consists of participation in the following two experiments :

a) *Search for solar axions using ^{83}Kr (2003-04, master thesis)*

My first search for solar axions was related to an experiment conducted at the Laboratory for electromagnetic and weak interactions at the Rudjer Bošković Institute during 2003 and 2004.

The idea was to search for monoenergetic 9.4 keV hadronic axions that could be emitted from the Sun by M1 de-excitation of thermally excited ^{83}Kr nuclei. It was assumed that these axions could be detected in a terrestrial laboratory with a gas proportional chamber filled with Kr gas using the

resonant axion absorption process in ^{83}Kr nuclei. Since no axion signal was found, an upper limit of 4.1 keV on the hadronic axion mass was set. I actively participated in the construction and tests of the experimental setup, as well as in data taking and data analysis.

b) *CAST experiment (2004 onwards, Ph. D. thesis)*
The CERN Axion Solar Telescope (CAST) is the latest and currently the most sensitive solar magnetic telescope. It is primarily designed to search for axions and axion-like particles with energies in the 1-10 keV range that could be produced in the Sun by the Primakoff conversion of thermal photons. When its 10 m long magnet is oriented towards the Sun, solar axions could convert to photons via inverse Primakoff process while traversing the 9 T magnetic field produced in the two parallel bores inside the magnet. As a result of the search for the Primakoff solar axions, CAST has set an upper limit on the axion-photon coupling constant for the sub-eV axion masses which supersedes all previous experimental limits and is comparable to the astrophysical limit. Since joining the experiment in 2004, I have been involved in data taking and analysis. During 2005, as a part of the transition to CAST Phase II, I also participated in the activities related to the upgrade of the CAST setup that was performed to enable precise filling of the magnet bores with helium in order to extend the sensitivity to higher axion masses.
My main activity in the CAST experiment was related to the search for monoenergetic 14.4 keV solar axions and axion-like particles that could be emitted from the Sun by de-excitation of thermally excited ^{57}Fe nuclei. I performed this search using the data acquired with the Time Projection Chamber (TPC) during Phase I of the experiment. It was the first time that solar axions whose production mechanism relies on the coupling to nucleons were sought via their conversion to photons in a magnetic field. This allowed to explore the relation between axion-photon and axion-nucleon coupling constants for a wide range of axion masses that had not been explored by previous experiments. This search was the subject of my doctoral thesis and it extended the CAST solar axion research program. I am also the corresponding author for the two articles of the CAST collaboration (number [5] and [11] in the List of Publications) that are related to this search.

2) <u>Neutrino oscillations</u> *OPERA Experiment (2000 onwards)*
Neutrino oscillation is a quantum mechanical phenomenon in which a neutrino produced as a certain type (ν_e, ν_μ or ν_τ) can spontaneously change its type as it propagates in space. The term "oscillation" refers to the fact that the probability for this change to occur is an oscillatory function of the distance traveled by neutrino from the source to the detector. My research of this phenomenon is related to the participation in the experiment OPERA (Oscillation Project with Emulsion Tracking Apparatus). This experiment has been designed for the first direct observation of ν_τ appearance due to $\nu_\mu \leftrightarrow \nu_\tau$ oscillation in the initially pure ν_μ beam produced at CERN and detected 730 km away in the underground Gran Sasso Laboratory (LNGS) where the OPERA detector is located. The apparatus consists of a lead/emulsion-film target complemented by electronic detectors. The ν_τ appearance can be deduced from the characteristic topological properties of the τ-lepton decay produced by ν_τ interaction in the detector. Such events can be identified by the analysis of tracks recorded in the emulsion films. I joined the experiment in 2000, shortly after it had been approved. That gave me the opportunity to participate in nearly all stages, from development of detector prototype in the early days to current data analysis. My first activities were related to prototype development of the Resistive Plate Chambers (RPC) that are used as a position sensitive detectors in OPERA muon spectrometers. I was specifically involved in the tests of the prototype performed with electron, muon and pion beams and the analysis of the test data. I was also involved in the making of computer simulations that were used to help the design of RPC. During the period of detector construction I participated in the testing of RPC detectors just prior to their installation in the muon spectrometers. These tests were used to check mechanical and electrical properties as well as the detector efficiency and response uniformity. Presently, I am working on the analysis of so-called Changeable Sheets (CS) emulsion film

doublets. This is one of the steps performed to reconstruct the tracks recorded in emulsion films in order to find the evidence of the ν_τ appearance signal.

3) **Remote control and monitoring of the processes and measurements** (2003 – 04)
In addition to the research of solar axions and neutrino oscillations, I participated in the science & technology project "Remote Control and Monitoring of the Scientific Experiment Using Mobile Phone and/or Internet" sponsored by the Ministry of Science, Education and Sport. The aim of this one-year project was to develop hardware and software platform for a generic system to remotely control and monitor various processes and measurements, e.g. experiments in physics, via SMS text messages, e-mail or web browser. As a part of this project I programmed a web-page and underlying interface programs to control the experiment that was in preparation at the Ruđer Bošković Institute at that time with a goal to search for paraphotons.

4) **Determination of the "CKM db unitary triangle" angles from the B meson decays** (1999, diploma thesis)
The Cabibbo-Kobayashi-Maskawa (CKM) matrix describes the coupling strength between quark flavors in charged weak interactions and explains the violation of CP symmetry in the Standard Model. As a consequence of the CKM unitarity constraints, there are six relations between CKM matrix elements that can be represented by the so-called "unitary triangles" in the complex plane. These relations, i.e. triangles, can be experimentally verified by studying specific weak decays. My diploma thesis is a theoretical work in which I analyzed how several B meson decay processes can be used to determine the angles of the so-called "db" unitary triangle.

LONG – TERM VISITS TO FOREIGN INSTITUTIONS

Since 2000 I have been spending several months per year at CERN (European Organization for Nuclear Research, Switzerland) and LNGS (Laboratori Nazionali del Gran Sasso, Italy) as a part of my activities in experiments OPERA and CAST.

TEACHING EXPERIENCE

Ruđer Bošković Institute is not related to any university so I do not have any teaching obligations. However, in academic year 2001/02 I gave several lectures on neutrino oscillations as a part of the elementary particle physics course for undergraduate students led by prof. I. Picek at the Department of Physics, Faculty of Science, University of Zagreb.

PERSONAL SKILLS AND COMPETENCES

Computer skills and competences

I have good command of :

- Programming languages : C, C++, Pascal, Fortran, HTML
- Packages used for data analysis and text processing : CERN ROOT, PAW, Mathematica, LaTeX, MS Office
- Operating systems : Windows XP, Linux

Technical skills and competences

Successfully completed course "Basic Radiation Safety for Radiation Workers" to work with radiation sources used in scientific and research laboratories

Social skills and competences

Through my activities in experiments OPERA and CAST I have gained a lot of experience in team work and communication in international environment.

CONFERENCES

- "*RPC as a target tracker detector in experiment OPERA*" (talk), Adriatic School on Particle Physics and Physics Informatics, 11-21 September 2001, Split (Croatia).
- "*Search for solar hadronic axions*" (poster), 9th International Symposium on Radiation Physics, 24-31 October 2003, Cape Town (Republic of South Africa).
- "*Search for solar axions using* ^{83}Kr" (poster), 4th Conference of the Croatian Physical Society, 13-15 November 2003, Zagreb (Croatia).
- "*CERN Axion Solar Telescope sensitivity to 14.4 keV axions*" (poster), 10th International Symposium on Radiation Physics, 17-22 September 2006, Coimbra (Portugal).
- "*Search for 14.4 keV axions using CERN Axion Solar Telescope*" (poster), 5th Conference of the Croatian Physical Society, 5-8 October 2007, Primošten (Croatia).
- "*Search for monoenergetic solar axions with CAST*" (invited talk), 5th Patras Workshop on Axions, WIMPs and WISPs, 13-17 July 2009, Durham (United Kingdom).
- "*Search for* ν_μ-ν_τ *Oscillations with OPERA Experiment*" (poster), 7th Conference of the Croatian Physical Society, 13-16 October 2011, Primošten (Croatia).

AWARDS

In 2003, I won the award as the author of the best poster among the 120 posters presented at the 9th International Symposium on Radiation Physics (24-31 October 2003, Cape Town, Republic of South Africa). The title of the poster was "*Search for solar hadronic axions*".