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To whom it may concern

Heidelberg, 16. Oktober 2012

Letter of Recommendation for Atri Bhattacharya

Dear colleagues,

it is my pleasure to recommend Dr. Atri Bhattacharya for a PostDoc position at your institution. I know Atri from collaborating on two papers and discussing with him on several occasions. His PhD advisor Raj Gandhi will surely provide a more detailed letter.

Atri is an expert on high-energy neutrinos and their effect in IceCube. He knows very well the aspects of standard neutrino fluxes and the effect of lepton mixing on their flavor decomposition. He understands the experimental aspects of how the different flavors can be identified in IceCube and he understands the physics of neutrino fluxes (sources, diffuse fluxes, Waxman-Bahcall limits, etc.).

His main expertise are effects of non-standard physics on the fluxes, for instance neutrino decay or Lorentz-invariance violation. Neutrino telescopes such as IceCube are unique tools for probing such exotic effects, and one can argue that due to the extremely high energies of the incoming particles, and the fact that neutrinos can be more naturally expected to have exotic properties, they are the only probes. Atri does not only know very well conceptually and analytically the underlying physics of such complicated non-standard aspects, but he can furthermore translate this into observables such as event numbers, i.e. values directly connected to experiments.

The first paper we have written deals with standard aspects and is called “The Glashow resonance at IceCube: signatures, event rates and pp vs. $p\gamma$ interactions” and has been published in JCAP. We have studied the Glashow resonance $\bar{\nu}_e e \rightarrow W$, using current limits on the diffuse flux, and evaluated event numbers as a function of the source, which could be pp reactions, $p\gamma$ reactions or a mixture of the two. For the first time, we noted that if the resonant W^- decays to a muon or tau instead of hadrons or electrons, then novel signatures are present, which we denoted as “pure muons” and “contained lollipops”. We showed that these new event classes are essentially background-free. This paper relied heavily on Atri’s numerical calculation of the event numbers, and his knowledge of the experimental aspects

of IceCube.

The second paper "On the interpretation of IceCube cascade events in terms of the Glashow resonance" was a reaction on the two cascade events which IceCube has announced at the Neutrino 2012 conference in Kyoto. At the time, the energy of the events was not precisely known, and could potentially lie around the value of 6.3 PeV that is characteristic for the Glashow resonance (unfortunately, it later turned out that they have much less energy). Nevertheless, we had the same idea as Barger, Learned and Pakvasa in arXiv:1207.4571, and argued that the absence of any muon track events leads one to consider cosmogenic neutrinos as the source of the events, since cosmogenics are dominated by electron neutrinos at low energies. However, unlike Barger, Learned and Pakvasa, we checked carefully the muon track event numbers of cosmogenic neutrino fluxes and found that they are too high. Thus, new physics needs to be included, and we showed that neutrino decay or Lorentz-invariance violation can sufficiently suppress the muon neutrino flux. This paper relied heavily on Atri's numerical calculation of the event numbers, and his knowledge and understanding of the non-standard physics.

He has two other papers on non-standard physics at neutrino telescopes, which surely will be discussed in the other letters. Finally, his other preprints on CPT violating effects in leptogenesis, and on astrophysical accretion flow, show that he has broader interests (also visible from his various study projects), and that he can work on other fields as well.

Atri's strength is in calculating analytically and numerically, where his numerical abilities are slightly stronger. His independence has grown considerably within the roughly 2 years that I know him. I believe he has great potential to grow further when thrown into an active environment.

IceCube, now running with all strings, and exploring new flux levels and energy values, is entering an exciting time. With Atri's knowledge of standard and non-standard physics aspects at IceCube, he is a perfect candidate for a group wanting to analyze and interpret upcoming data. Atri Bhattacharya can provide theoretical interpretation and provide results very close to experiment, which makes him a very attractive choice. He also has the skills to work on new fields as well, his interests are broader than his published papers show. I strongly recommend him for a PostDoc position.

With best regards,

A handwritten signature in dark ink, appearing to read 'W. Rodejohann', with a long horizontal flourish extending to the right.

Dr. Werner Rodejohann