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Dear Gustavo,

This is a letter of reference for **Dr. Subhaditya Bhattacharya** who is applying to Lisboa for a research position.

We hired Subha because of his broad background and his inclination to work in phenomenology. We were not disappointed. He proved to be an intelligent and insightful young researcher, with a solid knowledge of the standard model and its most interesting extensions, as well as a good nose for finding interesting problems and issues. He has the necessary technical background (mathematical and computational) and can easily assimilate whatever tools he is lacking in a short time. Physics-wise he is well learned in all aspects of the Standard Model and its supersymmetric extensions. While at UCR he has learned the most important aspects of the effective Lagrangian approach as well those aspects of dark matter physics most relevant to particle phenomenology. He also became conversant with the astroparticle aspects of dark matter (DM).

We have worked together in a series of papers (with F. del Águila – U. de Granada, A. Santamaría and A. Aparici – U. de Valencia) investigating low energy lepton number violation using both specific models and effective Lagrangians. Subha's expertise proved invaluable in the estimation of the phenomenological effects (low energy as well as at the LHC) and in understanding the symmetries and properties of the models being studied. He is now working on detailed LHC predictions for such theories.

In another project, now nearing completion, we collaborated with A. Drozd and B. Grzadkowski (Warsaw U.) in a model where the dark matter sector contains a scalar and a fermion, with only the scalar interacting directly with the standard model. In this scenario we are able to investigate the effects of additional DM components and the constraints derived from both direct detection and the WMAP observations. Subha took it upon himself to understand physically the results of the numerical integration of the Boltzmann equation, which proved enormously useful in explaining the results as well as for confirming the numerical output. He also provided the interpretation for various effects as well as for the crucial role played by the ratios of the masses of the DM components. Throughout this project Subha was careful and thorough and insightful.

Because of his expertise in M calculations Prof. B. Melic, who is currently visiting UCR invited Subha to participate in another project wherein the DM sector is assumed to be described by a non-linearly realized field theory. I know that Subha has also worked with E. Ma in various other aspects of neutrino physics where he has been very productive.

Summarizing: I found Subha to be thoughtful and creative, especially when considering the phenomenological viability of the models being considered, both in its low and high energy aspects. In deriving results he makes sure he understands their physical origin, their implications and significance, as a consequence his conclusions are very reliable. As a collaborator he is friendly and helpful, able to work independently as well as collaboratively. I recommend him to you most highly.

Sincerely,

José Wudka
Professor of Physics
Chair of the Riverside Division