

Dear colleague:

Application by Mr. Syed Shabbar Raza Rizvi for a postdoctoral position in your group

I would like to strongly recommend Shabbar Raza for a postdoctoral position in your group. I got to know him about 3 years ago, when he joined the High Energy Theory Group in University of Delaware which my long term collaborator Prof. Qaisar Shafi belongs to. Since then, I have been collaborating with Shabbar.

Last year, with Shabbar and Qaisar, we have published one paper on the particle spectroscopy on supersymmetric GUT models with non-universal gaugino masses. In the work, we have noticed that gaugino masses do not necessarily need to be universal at the GUT scale even if a certain GUT model is assumed. This is because the hidden sector field which gives the gaugino mass can be non-singlet under the GUT gauge group. Requiring the GUT gauge coupling remains perturbative up to the Planck scale, the representation of the non-gauge singlet hidden sector field is determined. For example, a $\mathbf{54}$ -plet is the unique choice in $SO(10)$ model. In this case, the ratio of the MSSM gaugino masses at the GUT scale is determined by $SO(10)$ group theory and therefore, only one gaugino mass input is sufficient to parameterize the three MSSM gaugino masses at the GUT scale, just like in the constrained MSSM (CMSSM). Assuming the universal sfermion masses and A -parameter as in the CMSSM, we have performed random parameter scan to examine a variety of phenomenological constraints, such as the relic abundance of the neutralino dark matter, the Higgs boson mass and the rare B-meson decays, as well as direct/indirect dark matter direction experiments. We have found that the allowed parameter region appears quite differently from the CMSSM results because of the non-universal gaugino masses.

Numerical analysis is the heart of this work, for which Shabbar played an essential role. Although I have cross-checked several points by using different codes, all the analysis, basically, has been done by Shabbar, employing ISAJET. I appreciate his skills on numerical analysis very much. On the other hand, he quite well understands underlying physics of the numerical results. During the project, we had a lot of discussion to qualitatively understand the numerical results and Shabbar gave very reasonable explanations. So, I also appreciate his physics abilities.

The discovery of Higgs(-like) boson with a mass around 125 GeV has a great impact on SUSY phenomenology. The 125 GeV Higgs boson mass favors a relatively heavy sparticle mass spectrum. On the other hand, the observed muon $g-2$ shows a significant deviation from the value predicted by Standard Model. Loop corrections via relatively light sparticles can reproduce the data. So, it is very interesting to examine a way of reconciling the Higgs

mass and the muon $g-2$ data in a reasonable SUSY breaking scenario. We have recently tackled this issue with a slight extension of CMSSM in the context of the minimal SU(5) GUT, where different soft term boundary conditions are introduced for different SU(5) multiplets. We have performed random scan of model parameters by imposing a variety of phenomenological constraints and found that there exists a parameter region which simultaneously reproduces the 125 GeV Higgs mass and the observed muon $g-2$ data within experimental errors, as well as the correct relic density of the neutralino dark matter etc. Shabbar have played the central role also on this project. Our paper is in preparation.

Finally, I would also like to write about Shabbar's personality. Shabbar is a very cheerful, friendly and kind person. I always enjoyed discussing and talking with him when I visit the University of Delaware and when I have phone meetings. Also, I should mention that he is a hardworking person. It is quite often that I receive emails about our project such as results of his numerical analysis in midnight. I sometimes ask him to do some numerical analysis to cross-check my results for other projects, not including him as a collaborator. He always gives a quick response and sends me his results in a short time. I very much appreciate not only his attitude to physics research but also his kindness.

Yours sincerely,

A handwritten signature in black ink that reads "Nobuchika Okada". The signature is written in a cursive, flowing style.

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