

Review #1

Proposal Number: 0822690
Performing Organization: VA Polytechnic Inst
NSF Program: Physics Frontier Center
Principal Investigator: Vogelaar, Robert B
Proposal Title: Center for Neutrino and Astroparticle Physics (CNAP)
Rating: Very Good

REVIEW:

What is the intellectual merit of the proposed activity?

The proposals aims at establishing a Center for Neutrino and Astroparticle Physics (CNAP) by combining research groups at four universities û Virginia Tech, North Carolina State University, University of North Carolina, and Duke University.

Intellectual merit of the proposed activity: There is currently a wide range of activities concerning neutrino physics at all four institutions. Theoretical and experimental work addresses topics in particle, nuclear, solar and astrophysical physics. Of the major activities (MA's) proposed, the first one concerns neutrino phenomenology and represents largely a theoretical activity. The second, neutrino technology, is largely technical and is concerned with R&D towards detector development, detector characterization, material evaluation and prototyping, and towards electronic and mechanical engineering. The third, neutrino frontier, is largely experimental and searches for new physics and appropriate techniques.

The proposal discusses a plethora of approaches, studies and technical developments that are presently being pursued at the four institutions and, in addition, in external collaborations at large neutrino experiments and underground laboratories. The multitude of activities in itself cries for coordination and a more concerted approach. It is not clear that the proponents have that in mind. The emphasis is more on interdisciplinary collaboration (definitely a good goal) and the extension of effort and technical capabilities. There is a set of experiments where investigators from the intended CNAP already play lead roles (BOREXINO, MAJORANA, LENS, liquid noble-gas detectors). Whether it is these, or other activities described, there seems to be a need to structure and focus the program, otherwise there is the danger of a quantitative but not necessarily qualitative extension of the current activities.

This all said, nevertheless, the science being addressed is fascinating and largely at the

forefront of physics in the various areas mentioned or, more generally, in neutrino physics (with the exception possibly of some of the more exotic detector developments, although, of course, a live low-energy neutrino detector is a great goal to strive for). This applies to neutrino phenomenology as well as to experiments seeking the nature of the neutrino and violation of lepton number conservation, or the question of possibilities to measure lepton CP violation in the neutrino sector. A timely and critical program is the refinement of the science case for DUSEL, and subsequently the construction of the detectors and experimental setups. The number of studies listed is absolutely fascinating. However, to repeat: a successful center will need to identify priorities and develop a concerted science program. The strong theory effort proposed, as well as the extensive technical developments of detectors are additional strengths of such a program but also need setting of priorities and a certain alignment with the science goals for the center to excel overall. It appears that the proposed organizational structure of the center, and the advisory as well as operational committee structure already has features aimed at such an approach.

What are the broader impacts of the proposed activity?

Broader impacts of the proposed activity: All four universities involved in CNAP have strong programs in education and outreach, ranging from the physics community, to student training, to K12 education, to public outreach. Teacher training, cutting-edge workshops, the Science House, summer programs, the NC Museum of Natural Science are just some of the highlights. NCPA will capitalize and expand on these (as illustrated with the letter from the Museum). Astrophysics is capturing the imagination of students and the public. Combined with the fascinating physics of the neutrino the proposed center activity can have broad impact on education and outreach and intends to do so.

Summary Statement

In Summary: I rate this as a very good proposal in a fascinating area of research. Excellent strengths exist in a broad spectrum of neutrino research already carried at all four institutions. The proposed coordination in general, and the major activities proposed in particular, represent a program of highly interdisciplinary character. It is grouped into the proposed MA's and these again in a number of sub-headings. While a frontiers center should be broadly conceived, nevertheless there should be something said about a focus on selected key goals and priorities and on a resulting structured program for the center. A pure collection of activities may have some potential for leading to joint programs, but the overall outcome might not be too different from the linear sum of its contribution and might lack added value. This needs some attention. The education and outreach programs appear to be excellent.

Review #2

Proposal Number: 0822690
Performing Organization: VA Polytechnic Inst
NSF Program: Physics Frontier Center
Principal Investigator: Vogelaar, Robert B
Proposal Title: Center for Neutrino and Astroparticle Physics (CNAP)
Rating: Multiple Rating: (Excellent/Very Good)

REVIEW:

What is the intellectual merit of the proposed activity?

Perhaps the most exciting discoveries in physics in the last decade were in the broad category of neutrino physics. Now, the field is maturing and instead of scattered and in some sense accidental results, it is aiming at planned large scale research that requires coordinated effort of larger groups composed of experts in variety of subfields.

The goal of the CNAP proposal is to established such an integrating entity that would overcome the traditional boundaries of particle physics, nuclear physics and astrophysics which were characteristic of the study of neutrinos in the past, and hindered it to some extent.

The idea that four large research universities that happen to be geographically close to each other can form such a center is excellent. The list of personnel and their past achievements is impressive and the support of the involved universities, and in particular the existence of the Kimballton facility, makes the proposal very attractive.

Among the proposed major activities I wish to comment primarily on the Neutrino Phenomenology, field closest to my own interests. This activity, in particular, has been a domain of individual researchers, often working in isolation of each other. The CNAP, if realized, would provide a needed coordination as well as a breeding ground for new students and postdocs. It is so important that particle phenomenologists working e.g. on the issue of the best strategy to determine, say, CP violating phase or checking whether neutrinos have nonstandard interactions, work side by side with nuclear physicists working on the bb -decay matrix elements or on the determination of the neutrino-nucleus cross sections, as well as with astrophysicists working on problems of supernovae or nucleosynthesis. The CNAP has experts in all these fields.

While the work on 'Neutrino Phenomenology' is important, and should be supported if at all possible, the 'Neutrino Technology' activity

is perhaps the most impressive part of the CNAP proposal. Progress in neutrino physics is impossible and would be hollow without new experimental results which, in turn, are impossible without technological innovations. The CNAP center would play an important role in that effort.

What are the broader impacts of the proposed activity?

Study of neutrinos impact broad areas of physics and technology. Supernovae are a primary example. The explosion mechanism remains unknown. The role of supernovae in nucleosynthesis is not well understood, etc. CNAP activities will help in answering these questions that will, in turn, impact the other fields.

Another example is the observations of geoneutrinos. If the flux of geoneutrinos can be measured, ideally in several locations, the impact of such knowledge on geophysics would be substantial.

Another aspect is technology. Experiments with neutrinos are notoriously difficult. Development of large detectors, requirements of radiopurity etc. are pushing the technology on many fronts. Again, CNAP activities will, no doubt, involve desirable byproducts of this type.

Summary Statement

Centers analogous to the proposed CNAP exist, or are being established, elsewhere (Germany, Japan). The establishment of a center like CNAP would be a very positive development if the US physics and astrophysics community wishes to keep its role in the neutrino field.

Many important and surprising discoveries were made in the recent past. We know that neutrinos are massive and mixed, and that they are very different from the other fermions. But important things remain unknown: Are neutrino Majorana particle?, Is CP symmetry violated?, Where in the sky are the heavy elements made? etc. To answer these questions, we need well funded and coordinated effort.

NSF is committed to establish the DUSEL facility. To fulfill its promise, that facility will need well prepared experiments. CNAP will play an important role in planning and conducting them.

The synergy between particle physics, astrophysics and nuclear physics is a rather new phenomenon. It is most strongly established in the study of neutrino properties and the phenomena caused by neutrinos. The CNAP center would be a good place to promote this interdisciplinary approach.

Review #3

Proposal Number: 0822690
Performing Organization: VA Polytechnic Inst
NSF Program: Physics Frontier Center
Principal Investigator: Vogelaar, Robert B
Proposal Title: Center for Neutrino and Astroparticle Physics (CNAP)
Rating: No Rating

REVIEW:

What is the intellectual merit of the proposed activity?

In principle, a focused research group pursuing experiments and theory in closely related fields is an attractive idea. The proposed Center for Neutrino and Astroparticle Physics (CNAP), with three major areas of activity ("Neutrino Phenomenology, Neutrino Technology, and Neutrino Frontier"), would associate experimental and phenomenology groups from Virginia Tech (in Blacksburg, VA), Duke University (in Durham, VC), University of North Carolina (in Chapel Hill), and North Carolina State University (in Raleigh, NC). With an access to the Triangle Universities Nuclear Laboratory (TUNL), supported by DOE, and the Kimballton Underground Research Facility (near VT), and local resources at four involved universities, which include computing farms, shops, cleanrooms and well-equipped laboratories, the proposed Center could potentially offer healthy environment for a wide variety of research studies and possibly expand the current use of available facilities.

Currently, members of the proposed Center are supported (by DOE and NSF) on several running, planned or experiments under construction. A list of the former includes Super-Kamiokande, KamLAND, Majorana and LENS, the latter are Daya Bay, T2K. Looking at this superficially, this portfolio presents a set of very interesting directions and opportunities to explore important issues related to neutrinos. However, one may also ask a "counter" question whether this is the most cost-effective way to advance these fields and whether this, as proponents suggest, allows these groups to play "leading" roles. From what this reviewer knows about the mentioned projects, the answer is "No". It is undeniable that some members (e.g., Raghavan) have provided seminal or crucial ideas for LENS and Borexino. Their overall role in Borexino is important and should be the focus for the VT group. However, it would be a big leap for these groups to truly lead these projects, even with the requested (huge amounts of) funding.

Most of the faculty involved in the proposed Center are established and solid contributors to the field of neutrino physics and astrophysics. Some of the younger members (Scholberg, Huber) are already well known and may become future leaders of the field. This reviewer is not familiar with the work of all the PI's and decided to run a rudimentary SPIRES check of citations over the last 10 years for the PI's listed on the cover page of the proposal. Vogelaar (VT) has published 21 papers which have 472 citations. About half of these citation is attributed to one "very well-known" and two "well-known" papers, 2 published in 1998, and 1 in 2002. For Raghavan (VT) the record shows 23 papers with 342 citations, again about a half attributed to two papers in 1998 (the same two with Vogelaar). A. E. Champagne (UNC) has 22 papers with 392 citations out of which 283 are from one paper co-authored with about 30 authors including J. Bahcall, B. Balantekin, S. Elliot, S. Freedman, M. Kamionkowski, et al. G. McLaughlin (NCSU) has 35 papers with 582 citations. K. Scholberg has 80 papers with 14617 citations (shows the visibility of Super-Kamiokande!). Checks for some other members (e.g., Link and Huber) show quite solid records. With an obvious exception of K. Scholberg's, these records are not impressive and perhaps reflect the difficulty with which Borexino struggled over the years.

CNAP, if funded, would command significant human resources and the budget in excess of \$3M annually. 10% of this budget would be used for the administration of the Center (this may be reasonable given that VT is located about 200 miles from Durham); this is about as much as for the budgeted outreach. The proposal requests funding for 8 post-docs and 8 graduate students and 12 undergraduates. This is to be distributed among the four institutions as specified in the budget forms. This is about 40% of the budget. The balance would fund 6-8 staff members, travel, and outreach and educational programs. The management of the Center is reasonable although it seems that the Director (the position is earmarked for Vogelaar) would have a lot of power and would be hard to replace (although this is not clear since no details on by-laws of the Center are provided in the proposal). On the other hand, the list of the members of the International Science Advisory Board is very impressive and includes some big names in neutrino physics. A national laboratory could be envious of this list.

What are the broader impacts of the proposed activity?

The proposed Center plans to develop partnership with successful projects at the four universities and increase the opportunities for undergraduate and graduate students as well as for post-doctoral fellows. The Science House at NCSU and VT's Institute for Connecting Science Research to the Classroom are well-known and well run outreach operations. It is possible that the Center would enrich and expand these programs involving both the junior cadre (students) and specially hired personnel. Since the neutrino physics cuts across many topics in physics, astrophysics, astronomy, and cosmology the additional educational potential of the Center is high and attractive. Again, the challenge will be how to assure that students at four distant universities can have similar access and opportunities. The foreseen use of video technology goes in the right direction but general experience shows that such effort is very hard to maintain for longer

periods of time.

Summary Statement

In summary, although the idea for the proposed Center for Neutrino and Astroparticle Physics (CNAP) is interesting and attractive in principle, this reviewer remains skeptical that CNAP would advance the field of neutrino physics more than it could be accomplished if the available funds were distributed to already existing groups (in the US) to allow them to play stronger leading roles in their current experiments or phenomenological studies. The main factors why this reviewer is unconvinced are: 1) the average quality of the members of the proposed Center is at best on par with the quality of faculty involved in leading neutrino experiments in the US, 2) the distance between institutions will make the proposed human interactions difficult and hard to maintain for a long term, 3) the track record of the involved experimental groups in recent neutrino projects has had its ups and downs and, although overall fairly positive, one may question whether the funds requested by the proposed Center would be best utilized as described in the proposal, 4) diversity of the proposed program is intellectually attractive but also challenging and defocusing, 6) it is not clear how in practice the researchers from four universities will tune in to each others tastes and needs to enhance their research so far and find common topics to work on in the future, 7) the management plan of CNAP seems shallow and overly centralized.



Review #4

Proposal Number: 0822690
Performing Organization: VA Polytechnic Inst
NSF Program: Physics Frontier Center
Principal Investigator: Vogelaar, Robert B
Proposal Title: Center for Neutrino and Astroparticle Physics (CNAP)
Rating: Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

Neutrino physics and astrophysics has provided some of the most exciting discoveries during the last decades. This proposal intends to bring together the neutrino physicists at four universities in the Southwest to form the core of a national center. The proposed center will form a forum providing resources to address specific challenges. I particularly like feature where the Center will carry out both theoretical and experimental activity as such synergy is a must for further progress in the field. Many proposals talk about bringing theorists and experimentalists together for workshops et cetera, but not to carry out the research together. I believe this is one of strengths of this proposal.

Three major activity areas, namely neutrino phenomenology, innovation in neutrino related instrumentation, and research on the neutrino frontier are well-chosen to maximize the impact of the Center. Progress in neutrino physics requires input from the first two major activity areas, namely a careful assesment of the existing data and development of new detection techniques. The Center can then build on the existing strengths of the members to establish a national forum for the third major activity area.

The management is plan is very carefully laid out. It is the most detailed plan I had seen a proposal of this kind for a long time.

What are the broader impacts of the proposed activity?

Neutrino physics has potential to impact not only nuclear and high energy physics, but also astrophysics and cosmology. In addition the proposers have a carefully laid out detailed outreach program.

I believe that it is an additional plus for the proposal to include two

best young (below the full professor category) female neutrino physicists in the country.

Summary Statement

Neutrino physics still has untapped potential to answer some of the most challenging questions about nature. The proposed Center has a very high probability of success in this endeavour and I recommend its funding.

Review #5

Proposal Number: 0822690
Performing Organization: VA Polytechnic Inst
NSF Program: Physics Frontier Center
Principal Investigator: Vogelaar, Robert B
Proposal Title: Center for Neutrino and Astroparticle Physics (CNAP)
Rating: Good

REVIEW:

What is the intellectual merit of the proposed activity?

see summary statement

What are the broader impacts of the proposed activity?

see summary statement

Summary Statement

This review is incomplete. I will submit the complete review within a week in the hope that it will be useful.

What is the intellectual merit of the proposed activity? Will it address intellectual frontiers of physics, broadly interpreted?

The intellectual merit of the proposed activity is excellent. It would address leading questions on the properties of neutrinos (mixing angles, masses, CP violation, Majorana vs Dirac, gauge couplings) and on phenomena which could be potentially studied using neutrinos (core-collapse supernovae, nuclear structure, dark matter, etc.). The caliber of the investigators is very high on the whole. Many are well-known in the fields of neutrino physics and neutrino astrophysics; others have expertise which

could be applied to address these questions.

What are the broader impacts of the proposed activity, including impacts on other fields, technology, society, and workforce?

The basic knowledge derived from this research could have a significant impact on particle physics, nuclear physics, astrophysics, and cosmology. Detector development could produce technological spin-offs. Involvement of students in this research typically improves skills useful for dealing with technical measurement and analysis issues.

What is the educational impact of the proposed activity and does it integrate research and education's

VT and NCSU have successful programs which disseminate advances in knowledge and pedagogy to K-12. The proposed activity would establish a close relationship with these programs.

The proposal includes letters of interest and support from these programs.

The numbers of individuals who would receive undergraduate, graduate, and postdoctoral training from this activity are 65, 36, and 41, respectively. This is in line with the overall level of funding requested. A REU program would also be pursued.

Does the proposed work contribute to the goal of integrating diversity into NSF programs, projects, and activities?

The proposed activity would involve two historically black universities, North Carolina Central and South Carolina State. Of the two investigators in the center from these universities, one has a research record in neutrino physics.

Students from these schools would have a clear opportunity to participate in the work of the Center. A modest amount of equipment would be transferred to these schools to allow students to continue their research on campus.

Evaluate the intrinsic technical merit of each of the major activities (MAs) of the proposed PFC.

There are three major activities: neutrino phenomenology,

neutrino technology, and neutrino frontier. Neutrino technology is the strongest in terms of feasibility, critical mass of investigators and facilities, and breadth.....

Evaluate the proposed PFC as a whole. Is there strong synergy, value-added, or other collective attributes that makes the proposed PFC more valuable than a set of individual awards with the same total funding?

The range of research spanned by the proposed PFC is broad, especially in the area of experimental physics. The proposed activity has the potential to become a strong center.

As it is described, however, I think that it is likely that the impact would not be much more than if the investigators were separately funded. The reasons are as follows:

1) I would expect that the Center would be the main activity of its director. In fact, the director would be an investigator on other major grants and there is no mention of any teaching release.

2) The proposal does speak to activities that would encourage interaction and collaboration between the researchers within the center and with researchers outside the center. It also speaks to development of infrastructure and facilities which would enhance the ability of the center to reach its goals. However, I would have expected considerably more resources to have been allocated to visitor programs, seminar series, and workshops than is found in the budgets. Also, what is budgeted for capital equipment and material and supplies is either more along the lines of building up parallel capability at the individual institutions or does not enhance the capability of facilities such as KURF beyond what could be achieved with individual award to groups which have specific interests in using KURF.

3) The investigators have many proposals pending which overlap in scope with this one. Furthermore,

as would be expected, the investigators are already very active.

Involvement in this center requires not only more students, postdocs, and equipment but also intellectual engagement and investment of time by the investigators.

The proposal does not describe very much what would be done to support/encourage the investigators so that they are able to help make the center a success.

Evaluate the institutional setting, management plan, budget, shared equipment, infrastructure, etc.

Still to be answered....

Note other strengths or weaknesses or other comments relevant to the proposed PFC.