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# Korean SCES Community and APCTP

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## ABSTRACT

About 20 years ago, the number of researchers in Korea – both theory and experiment – working on strongly correlated electron systems (SCES) was only a handful, while it was a booming period for the international SCES research community because of the stimulating challenge of the famous high- $T_c$  cuprate superconductors. Here I summarize a brief history of how the Korean SCES community has grown in parallel with the APCTP in the last 20 years.

## INTRODUCTION

### The stage

In 1986, Bednorz and Mueller discovered the cuprate superconductor BaLaCuO with  $T_c = 30\text{K}$ , and in the following year M K Wu and C W Chu reported the 93K superconducting compound YBCO. The whole world – both scientists and the general public – was excited about these new quantum materials. Besides the dream of “room temperature superconducting material” as a second material revolution after semiconductors, these new materials brought new life to an old problem: in narrow sense, it has revealed that our understanding of metals and superconductors was far from complete; in wider sense, it just reminded us that we do not have any reliable method to solve many body systems when the interaction is strong (surely, the most famous example was QCD in particle physics). It was simply the good fortune of condensed matter physics that the abundant number of materials around us – if not all – are weakly interacting systems (hence, these systems can be dealt as non-interacting systems after some form of mean field treatment of interactions) such as ordinary metals, semiconductors,

and old low- $T_c$  superconductors, etc. However, the newly discovered high- $T_c$  cuprate superconductors maximally defy this fortunate situation, and now condensed matter physicists have to face up to interacting systems without an option of hiding. In a fundamental sense, that was the essence of high- $T_c$  superconductors and SCES, and that is the reason why the problem of SCES has attracted a wide range of physicists besides condensed matter physicists.

### The beginning

When the APCTP was launched in 1996, it collaborated with and also benchmarked with the ICTP (International Center for Theoretical Physics, Trieste). Prof. Y. M. Cho (the first executive director and a founding member of the APCTP) had visited the ICTP many times before 1996 to prepare a master plan for the new center, and had observed the exciting activities on SCES at ICTP. At that time, the group head of the condensed matter physics at ICTP was Prof. Yu Lu, and under his leadership the ICTP summer school became the mecca for researchers of SCES and high- $T_c$  superconductors. Impressed by this active development of a new field in theoretical physics, Prof. Y M Cho emphasized the importance of SCES research at APCTP from the very beginning. This was an excellent foresight in retrospect. Traditionally, until mid 90's, it was common sense that major theoretical physics institutes around world focus on elementary particle physics – string theory and quantum gravity, for example – and other fields of physics were considered to be of secondary importance. However, nowadays, it is also very common to find that the research on SCES and theoretical condensed matter physics, in general, is the main focus in many theoretical physics institutes: for example,



The APCTP Quantum Materials Symposium 2017.

Kavli institute (Santa Barbara), Max-Planck Institute (Dresden), Perimeter Institute (Waterloo, Canada), etc.

When the APCTP opened in 1996 in Korea, only a handful of researchers were working on SCES and high- $T_c$  superconductivity and some of them (H.K. Won, H.Y. Choi, T.W. Noh, J.H. Kim, J.J. Yu, and me) gathered and organized the first winter workshop on high- $T_c$  superconductivity at the Sungwoo ski resort (Kangwon province) in 1997. Although this workshop was quite spontaneously proposed – Prof. H.K. Won first proposed this idea and she was the only person who had experience of skiing among us – it was a pioneering idea and excellent decision, in retrospect. Among others, it was the first science workshop held at a ski resort in Korea with a government grant (in those days, skiing and ski resorts were considered a luxury). After our workshop successfully ended without any subsequent complaint from the funding agency, ski resort workshops quickly became a popular trend in Korea. Of course, the booming Korean economy and expanding ski resort places in that period provided a favourable environment, too. This first workshop was rather small scale with only about 40 participants in total and nine or ten speakers altogether. However, Prof. Y M Cho had noticed the importance of our workshop and began to support it from 1998 – Prof. Cho was an extreme ski lover by himself, just to mention it. Since then, it was officially named as “The APCTP winter workshop on SCES” and it became one of the most successful APCTP sponsored activities. Although the total budget



for the workshop needed various other sources besides the APCTP, it would have not been possible to continue this winter workshop in the following 20 years without the continuous sponsorship by the APCTP.

### The growth

I can say that through the APCTP winter workshop on SCES, the Korean SCES community was cultivated and shaped into its current form. It provided an efficient channel for domestic researchers to absorb firsthand knowledge and progress in the field, and also offered an important platform for exchange and communication between Korean researchers and foreign researchers, in particular, with researchers of neighbouring Asian countries such as Japan, China, Taiwan, etc. It also provided an opportunity for students and young postdocs to be exposed to the leading scholars from abroad and some of

them went abroad to continue their study and research. Then, after several years, I observed that many of those who participated as students in the early period and went abroad to study further, began to return to Korea as mature researchers and become faculty in various universities and government research labs. To me, this was the most surprising development that I have observed as a result of this winter workshop activity, because it happened over a period of less than 10 years. I deeply realized the importance and power of nurturing the younger generation through right guidance and a beneficial environment.

With time passing, the Korean SCES community has rapidly grown in terms of quality as well as quantity. Also the research subjects of SCES has become diversified from the traditional ones to newly emerging subjects like various unconventional superconductors, GMR and CMR, heavy fermions, quantum criticality, multi-ferroics, low dimensional electronic systems, quantum magnets, etc. Accordingly, the size of the Korean SCES community has also grown to form several active research groups focusing on different subjects, and we felt that it is necessary to expand the scope of the APCTP winter workshop to embrace a wider range of researchers. In 2012, several working groups – including IBS-CCES center (Seoul, Director TW Noh), KIAS (K Park), and later joined by IBS-CALDES (Pohang, Director HW Yeom) – agreed to embrace a wider community in the APCTP winter workshop. As a result, since 2013, we renamed “APCTP winter workshop on SCES” as “APCTP Quantum Material Symposium” and expanded the size of the workshop so that it covers a wider range of newly developing subjects in SCES physics. It was very successful in becoming the unified annual activity of the Korean SCES community. The high quality of the workshop attracts many more top rank foreign and domestic scholars as well as more participants. It functions as a good platform among the participating researchers for developing further exchange

and communication after the workshop, in particular, among the Asian-Pacific regional countries. After this expansion, the workshops from 2013 to 2017 (this year) had an average number of participants of about 200 people and 30-40 invited speakers during a workshop period of five full days. It became one of the flagship academic programs of the APCTP and I believe it will continue to grow further.

Finally, I also should mention that this APCTP winter workshop activity not only nurtured the Korean SCES community but also led to an increase in APCTP member countries. In 2007, the APCTP and the Korean SCES community supported “The 5th International Conference on Magnetic and Superconducting Materials (MSM07)”, (Khiva, Uzbekistan). With this joint activity, the Academy of Science of Uzbekistan became interested in the APCTP and Uzbekistan became a member country of the APCTP in 2011. India also became to know of the APCTP through our SCES workshop. With the passionate effort of Prof. D D Sarma (IIS, Bangalore), India became a member country of the APCTP in 2008, and The Indian Association for the Cultivation of Science and the APCTP have been jointly organizing the bilateral workshop on “novel oxides and SCES” every year since 2009.

## CONCLUSION

Here I have briefly presented a short history of how the Korean SCES community has grown with the help of the APCTP in the last 20 years. And I want emphasize that the growth of the Korean SCES community was not limited to inside Korea. Its growth mutually benefits the researchers and communities of all member countries as well. I believe that this was the main mission for which the APCTP was established 20 years ago, and this kind of mutual growth story with the APCTP will continue and spread over all member countries in the future.



**Yunkyu Bang** is Professor at Chonnam National University, Korea. After receiving Ph.D from Rutgers University in 1991, he worked at Max-Planck Institute (Stuttgart, 1991-93) and ICTP (Trieste, 1993-94). He also worked at Los Alamos Laboratory as a visiting scientist (2001-2003) and served as executive director of the APCTP (2012-13). His research field is theoretical condensed matter physics.