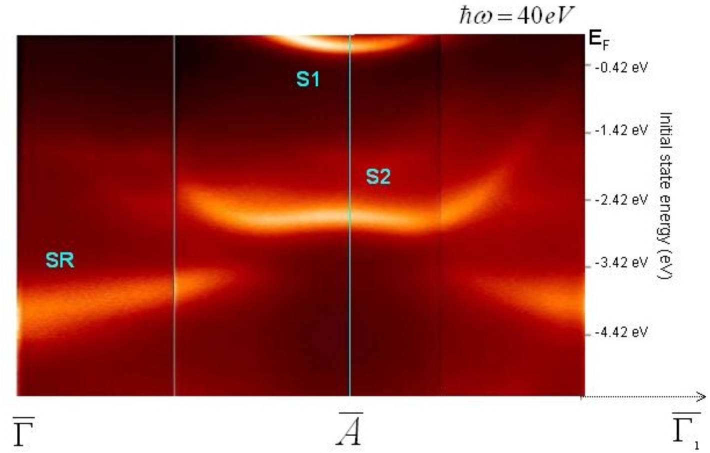
Direct Extraction of the Eliashberg Function from Photoemission Data (I)

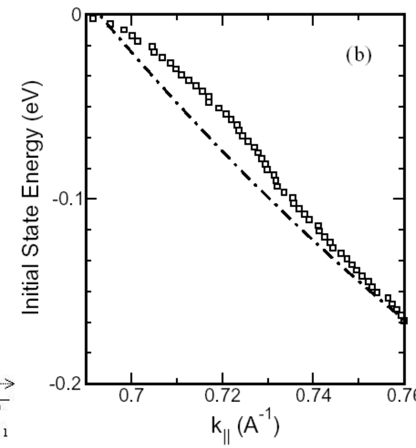
Ward Plummer, University of Tennessee, DMR-0105232

Electron-phonon coupling (EPC) is the basis for many interesting phenomena in condensed matter physics such as conventional superconductivity. Theoretically, the full characteristics of EPC are described by the Eliashberg function. Experimentally determining the Eliashberg function is crucial for understanding the basic mechanism for coupling.

We have developed a systematic procedure to directly extract the Eliashberg function from the high-resolution angle resolved photoemission spectroscopy (ARPES) data. The new procedure provides an unprecedented spectroscopic view of EPC. This procedure has been applied to the surface state on Be(1010).

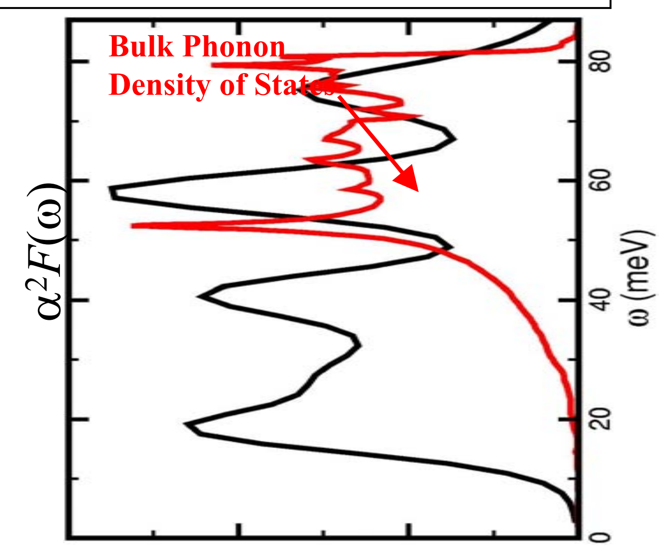
The new technique, coupled with the high-resolution ARPES, promises to revolutionize our understanding of electron phonon coupling in systems of reduced dimensionality.





The photoemission experiments were performed at the Advanced Light Source in collaboration with Z.X Shen's group.. Left: the photoemission image of Be(1010) surface (energy vs. momentum). Right: the quasi-particle dispersion for the S1 surface state extracted from the data.

The Eliashberg function for the S1 state of the Be(1010) state is extracted from the ARPES data (right). The Eliashberg function can then be utilized to evaluate other quantities such as the mass enhancement factor, critical temperature of the possible superconductivity, etc.



Direct Extraction of the Eliashberg Function from Photoemission Data (II)

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The Broader Impact of this Work

• **Training Students for the "work force" to keep the US competitive.** This project was a partnership between the University of Tennessee (UT), Oak Ridge National Laboratory (ORNL) and Stanford University (SU) which has created a unique environment for training students. This work is the thesis project of UT student Shu-Jung Tang and a postdoc, Junren Shi, at ORNL. The collaborations being set up between the PIs and scientists in Germany, Spain, Denmark as well at two government laboratories (ORNL and LBNL) will lead to unique opportunities for discovery and education.

The PI on this proposal has been training students and postdocs for thirty years so that the statistics are relevant to illustrate the societal impact. Of the ~60 graduate students and postdocs that have been advised or hosted by the PI in this period, 40 of them are working in the US, involved with science and technology. Fifteen of these people work in the private sector, ranging from electronics-based companies like Intel and IBM, to chemical companies like Dupont, research contract companies like the Sarnoff laboratory, to oil companies. Two have been involved in starting new companies. Sixteen work in the educational field, ranging from first-tier research universities to four-year teaching colleges. Eight work for the government in different capacities; one is a program director at NRC. One previous graduate student is now a patent attorney. Science is an international endeavor and the worldwide impact has also been significant, with directors of two major synchrotron facilities (NSRRC and BESSY II), a director at the Fritz-Haber Institute in Berlin, and a C4 professor in Germany coming out of this research group. Nine of these students or postdocs have been female and four hispanic.

• **Infrastructure for Research and Education.** The development of a "bullet proof" procedure for analysis of high-resolution photoemission data will become a standard software tool for the community.