# Half-metallic electronic structures and the observations in Heusler alloys

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## Introduction

Half-metallic ferromagnets have been intensively investigated in field of spintronics, since half-metallic electronic structures were theoretically predidcted in many half-Heusler and full-Heusler alloys. Since resonant inelastic X-ray scattering (RIXS) is a photon-in/photon-out spectroscopy technique, it allows us to probe the electronic structures in an elemental specific way by tuning the incoming photon energy. We successfully detected the electronic structures of $Mn_2VAl$ and $Co_2MnSi$ Heusler alloys by RIXS and the magnetic circular dichroism (MCD) [1-3]. Futhermore, the direct evidence of the half-metallic band structures of $Co_2MnGe$ using angular-resolved photoelectron spectroscopy (ARPES) could be observed [4].

## Experimental results

Mn $2p_{3/2}$ RIXS-MCD spectra for $Co_2MnSi$ and $Mn_2VAl$ single crystals were obtained at room temperature at SPring-8 BL07LSU. The distinct MCD contrasts are observed, indicating the high spin polarization of the Mn 3*d* states in both cases. The RIXS-MCD spectra for $Co_2MnSi$ show the negative fluorescence component of MCD with the energy gap from the elastic component, reflecting the down-spin gap of the half-metallic electronic structures of the Mn 3*d* states. On the other hand, the negative RIXS-MCD component in $Mn_2VAl$ are observed in the vicinity of the elastic component, suggesting that the down-spin states contribute to $E_F$. This is consistent with the predicted electronic structures of $Mn_2VAl$, in which the half-metallic gap is located in the up-spin state.

Experimental constant energy surfaces were observed for $Co_2MnGe$ by ARPES at SPring-8 BL25SU in the temperature of 30 K. They show fourfold symmetry that correlate with the symmetry of the (001) plane of the crystal. In a comparison with the calculated band structures, the observed features are well explained.

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## References

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