

# $\eta$ and $\eta'$ transition form factors

Reinhard Beck, Bastian Kubis

Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

## Hadron Physics Summer School 2014

The charge distributions of composite objects are characterized by *form factors*. Whether describing the cross sections for electron scattering off nucleons (composed of quarks and gluons) or nuclei (composed of nucleons), form factors parametrize the deviation from the scattering amplitude off a point-like object (like an electron); to study them allows us to learn something about the constituents as well as the strong interactions that bind them together [1]. The momentum dependence of the form factors can therein be understood as the Fourier transform of the charge distribution (within a certain reference frame).

Similar form factors can also be used to characterize the electromagnetic *transition* between different particles. In particular, we can also investigate the form factors of particles that cannot be prepared as targets in scattering experiments through the study of their *decays* into final states including an electron–positron pair. Of particular recent interest are the transition form factors describing the decays of light, flavor-neutral mesons ( $\pi^0$ ,  $\eta$ ,  $\eta'$ ) into one real and one virtual photon; with only one single hadron involved, it is this hadron’s electromagnetic structure that can be understood in such decays.

In this working group, we want to concentrate on the decays  $\eta, \eta' \rightarrow \gamma e^+ e^-$ . The decaying  $\eta$  or  $\eta'$  can be photo-produced in the reaction  $\gamma p \rightarrow \eta(\prime)p$ , both with the Crystal Ball experiment at MAMI (Mainz) or the Crystal Barrel experiment at ELSA (Bonn). We want to understand the existing experimental results for such form factors [2], how they can be understood and interpreted theoretically [3], and what their implications are for a wider range of modern particle physics problems of current interest [4]. Finally, we want to work on a proposal for improved experiments to measure the transition form factors.

## References

- [1] *see e.g.*: F. Halzen and A. D. Martin, *Quarks And Leptons: An Introductory Course In Modern Particle Physics*, New York, USA: Wiley (1984).
- [2] P. Aguilar-Bartolome *et al.* [A2 Collaboration], *A new determination of the  $\eta$  transition form factor in the Dalitz decay  $\eta \rightarrow e^+ e^- \gamma$  with the Crystal Ball/TAPS detectors at the Mainz Microtron*, Phys. Rev. C **89** (2014) 044608 [arXiv:1309.5648 [hep-ex]].
- [3] C. Hanhart, A. Kupść, U.-G. Meißner, F. Stollenwerk and A. Wirzba, *Dispersive analysis for  $\eta \rightarrow \gamma \gamma^*$* , Eur. Phys. J. C **73** (2013) 2668 [arXiv:1307.5654 [hep-ph]].
- [4] E. Czerwiński, S. Eidelman, C. Hanhart, B. Kubis, A. Kupść, S. Leupold, P. Moskal and S. Schadmand, *MesonNet Workshop on Meson Transition Form Factors*, arXiv:1207.6556 [hep-ph].