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Searching for mergers in early-type QSO host galaxies and a control sample of inactive ellipticals

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Abstract. We present very deep HST/ACS images of five QSO host galaxies, classified as undisturbed ellipticals in earlier studies. For four of the five objects, our images reveal strong signs of interaction such as tidal tails, shells, and other fine structure, suggesting that a large fraction of QSO host galaxies may have experienced a relatively recent merger event. Our preliminary results for a control sample of inactive elliptical galaxies do not reveal comparable fine structure.

Keywords. galaxies: active; galaxies: ellipticals; galaxies: interactions; quasars: general; quasars: individual (OX 169, PHL 909, PKS 0736+01, PG 0923+201, MC2 1635+119)

The ubiquity of massive black holes (BHs) in the center of galaxies shows that more than the mere presence of a massive BH is needed to trigger the activity observed in AGNs. Mergers are promising candidates and essential in at least one subclass of AGNs, ultra-luminous infrared galaxies (Canalizo & Stockton 2001). To study the relevance of mergers for the fueling of classical QSOs, we obtained very deep (5 orbits) HST/ACS images (F606W) of five QSOs residing in host galaxies that have been classified as undisturbed ellipticals in earlier studies (Dunlop *et al.* 2003). For all objects, deep Keck spectroscopy revealed major starburst episodes (∼1-2 Gyr; Canalizo *et al.* 2006). For four out of the five objects, our images reveal dramatic signs of interactions such as shells, tidal tails, and other fine structure (Fig. 1), suggesting that a large fraction of QSO host galaxies may have experienced a relatively recent merger event. One spectacular example of shell structure is MC2 1635+119. In numerical simulations, the observed shells can be produced in a minor merger event which may also have triggered the AGN activity. However, we cannot exclude other scenarios such as a major merger (Canalizo *et al.* 2007). Although all five QSO host galaxies are dominated by a de Vaucouleurs profile, an exponential profile contributes up to 26% to the total host galaxy light. The fine structure seen in four of the five QSOs contributes up to 6% to the total luminosity of the host galaxy (Bennert *et al.* 2007, in preparation). However, the question remains whether the QSO host galaxies are truly distinct from inactive ellipticals or whether we can find similar fine structure hinting a recent merger event. We selected a control sample of elliptical galaxies from the HST archive. We currently have ∼90 good candidates, including nine with spectroscopic redshifts. So far, none of the nine ellipticals has shown the spectacular fine structure found in the QSO hosts, although some have apparent companions.

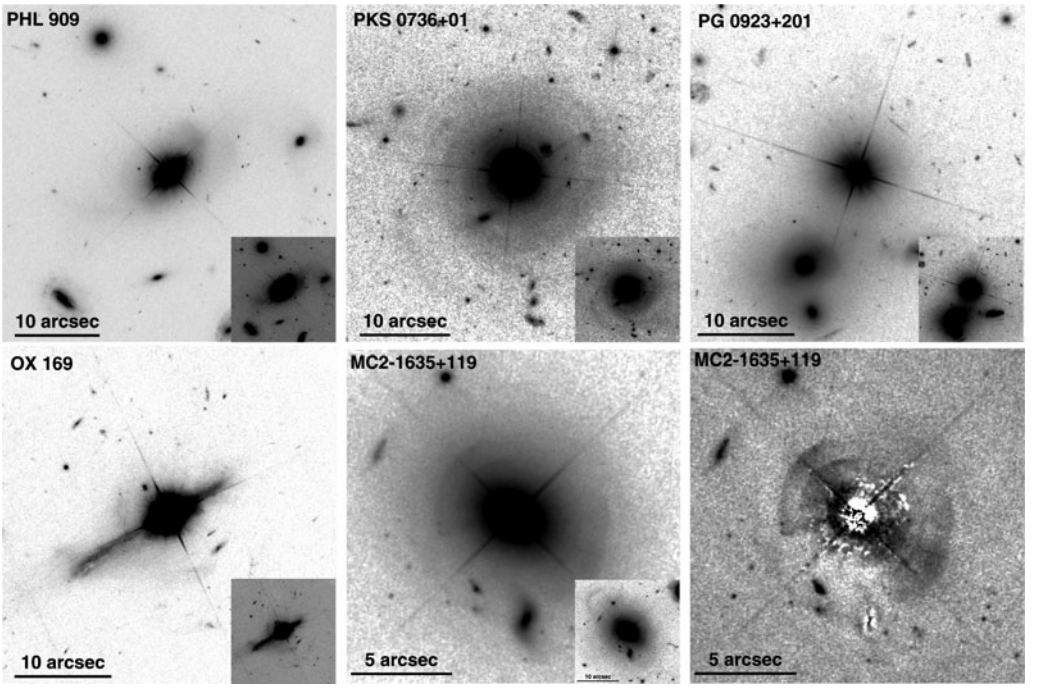

Figure 1. Deep HST/ACS images of five early-type QSO host galaxies. North is up, east is to the left. **PHL 909** (*top left*): A ring-like structure is seen around the QSO nucleus. Diffuse outer material form another ring and tidal tails to both sides of the host. **PKS 0736+01** (*top middle*): A large ($r \sim 50$ kpc) but faint spiral-like structure surrounds the QSO. The changes in pitch angle may indicate spatial wrapping of material from a merger event rather than a spiral disk seen face on. **PG 0923+201** (*top right*): No fine structure can be seen in the host galaxy, but it lies in an environment with several interacting companions. **OX 169** (*bottom left*): The extended linear structure is likely a tidal tail seen nearly edge on. Note the extended shell-like features east of the nucleus. **MC2 1635+119** (*bottom middle*): Spectacular interleaved shells occur at $r \sim$ 5-12 kpc. An arc-like feature extends out to ~ 32 kpc (*inset*). The shell structure is seen more prominently when subtracting a PSF+host galaxy model as fitted by GALFIT (*bottom right*).

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