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Probing the origin of flux-ratio anomalies in quadruple lenses with ALMA

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Image positions in some QSO-galaxy quadruple lens systems can be well fit by simple smooth galaxy mass models whereas observed flux ratios are more difficult to match. This mismatch is called "flux-ratio anomalies", which has long been veiled in great mystery. Our group have so far observed 4 mid-infrared quadruple lens systems and found that two of them show anomalies in their flux ratios. This anomaly has been considered as an imprint of CDM subhalos with a mass of $\sim 10^{8-9} M_\odot$ in the lensing galaxy. However, we have recently shown that such anomalies can be also explained by the weak lensing effects due to mini-structures with a mass scale of $\lesssim 10^8 M_\odot$ in intergalactic spaces. If this is the case, the anomalous flux ratios can be explained without conflicting the "missing satellite problem" since most of these structures reside in intergalactic spaces. In order to distinguish between the two models, we propose to observe the anomalous QSO-galaxy quadruple lens systems with ALMA. The size of dust continuum or line emitting region $\sim 100\,\mathrm{pc}$ is typically larger than QSO jets $\sim 10\,\mathrm{pc}$ or the IR continuum emitting region $\sim 1\,\mathrm{pc}$. Therefore, we can measure the differential magnification effect due to spatial change of the curvature of the gravitational potential. If the line-of-sight mini-structures are the cause of the anomaly, we expect that about a half of anomalous systems are perturbed by locally negative masses since void-like structures are volunerable to the tidal force in galaxy halos.