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A Runaway Black Hole in COSMOS: Gravitational Wave or Slingshot Recoil?

F. Civano (1), M. Elvis (1), G. Lanzuisi (1,2), K. Jahnke (3), G. Zamorani (4), L. Blecha (5), A. Bongiorno (6), M. Brusa (6), A. Comastri (4), H. Hao (1), A. Leauthaud (7), A. Loeb (5), M. Mignoli (4), V. Mainieri (8), E. Piconcelli (9), M. Salvato (10), N. Scoville (10), J. Trump (11), C. Vignali (12), T. Aldcroft (1), M. Bolzonella (4), E. Bressert (1), A. Finoguenov (6), A. Fruscione (1), A. M. Koekemoer (13), N. Cappelluti (6), F. Fiore (9), S. Giodini (6), R. Gilli (4), C. D. Impey (11), S. J. Lilly (14), E. Lusso (4,12), S. Puccetti (15), J. D. Silverman (14), H. Aussel (16), P. Capak (10), D. Frayer (10), E. Le Floc'h (17), H. J. McCracken (18), D. B. Sanders (17), D. Schiminovich (19), Y. Taniguchi (20) ((1)Harvard Smithsonian Center for astrophysics, (2)Universita` di Roma La Sapienza, (3)Max Planck Institut fur Astronomie, Heidelberg, (4)INAF-Osservatorio Astronomico di Bologna, (5)Harvard University, (6)MPE Garching, (7)LBL, University of California, (8)ESO Garching, (9)INAF-Osservatorio Astronomico di Roma, (10) California Institute of Technology, (11) University of Arizona, (12)Universita` degli Studi di Bologna, (13) Space Telescope Science Institute, (14)ETH, (15)ASI Science Data Center, (16)AIM Unite' Mixte de Recherche CEA CNRS, (17)University of Hawaii, (18)Institut d'Astrophysique de Paris, (19)Columbia University, (20)Ehime University)

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We present a detailed study of a peculiar source in the COSMOS survey at $z=0.359$. Source CXOCJ100043.1+020637 (CID-42) presents two compact optical sources embedded in the same galaxy. The distance between the 2, measured in the HST/ACS image, is $0.495''$ that, at the redshift of the source, corresponds to a projected separation of 2.46 kpc. A large (~ 1200 km/s) velocity offset between the narrow and broad components of H β has been measured in three different optical spectra from the VLT/VIMOS and Magellan/IMACS instruments. CID-42 is also the only X-ray source having in its X-ray spectra a strong redshifted broad absorption iron line, and an iron emission line, drawing an inverted P-Cygni profile. The Chandra and XMM data show that the absorption line is variable in energy by 500 eV over 4 years and that the absorber has to be highly ionized, in order not to leave a signature in the soft X-ray spectrum. That these features occur in the same source is unlikely to be a coincidence. We envisage two possible explanations: (1) a gravitational wave recoiling black hole

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(BH), caught 1-10 Myr after merging, (2) a Type 1/ Type 2 system in the same galaxy where the Type 1 is recoiling due to slingshot effect produced by a triple BH system. The first possibility gives us a candidate gravitational waves recoiling BH with both spectroscopic and imaging signatures. In the second case, the X-ray absorption line can be explained as a BAL-like outflow from the foreground nucleus (a Type 2 AGN) at the rearer one (a Type 1 AGN), which illuminates the otherwise undetectable wind, giving us the first opportunity to show that fast winds are present in obscured AGN.

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