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Building the largest spectroscopic sample of ultracompact massive galaxies with
the Kilo Degree Survey.

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Abstract:
Ultracompact massive galaxies (UCMGs), i.e., galaxies with stellar masses M_*_>8x10^10^M_{sun}_ and effective radii R_e_<1.5kpc, are very rare systems, in particular at low and intermediate redshifts. Their origin as well as their number density across cosmic time are still under scrutiny, especially because of the paucity of spectroscopically confirmed samples. We have started a systematic census of UCMG candidates within the ESO Kilo Degree Survey, together with a large spectroscopic follow-up campaign to build the largest possible sample of confirmed UCMGs. This is the third paper of the series and the second based on the spectroscopic follow-up program. Here, we present photometrical and structural parameters of 33 new candidates at redshifts 0.15<~z<~0.5 and confirm 19 of them as UCMGs, based on their nominal spectroscopically inferred M_*_ and R_e_. This corresponds to a success rate of ~58% , nicely consistent with our previous findings. The addition of these 19 newly confirmed objects allows us to fully assess the systematics on the system selection-and to finally reduce the number density uncertainties. Moreover, putting together the results from our current and past observational campaigns and some literature data, we build the largest sample of ucmgs ever collected, comprising 92 spectroscopically confirmed objects at 0.1<~z<~0.5. This number raises to 116, allowing for a 3{sigma} tolerance on the M_*_ and R_e_ thresholds for the ucmg definition. For all these galaxies, we have estimated the velocity dispersion values at the effective radii, which have been used to derive a preliminary mass-velocity dispersion correlation.

Description:
The ESO Kilo Degree Survey (KiDS) is one of the ESO public wide-area surveys (1350deg^2^ in total) being carried out with the VLT Survey Telescope. It provides imaging data with unique image quality (pixel scale of 0.21/pixel and a median r-band seeing of 0.65") and baseline. As baseline sample of our search, we use the data included in the third Data Release of KiDS (KiDS-DR3) presented in de Jong+ 2017 (II/347).

Spectroscopic follow-up data have been collected in the years 2017 and 2018 during three separate runs, two carried out with the 3.6m Telescopio Nazionale Galileo (TNG) and one using the 2.54m Isaac Newton Telescope (INT), both located at Roque de los Muchachos

Observatory (Canary Islands).
Data on 13 luminous UCMG candidates have been obtained with the IDS spectrograph during six nights in March 2017 at the INT telescope (wavelength range 4000-8000{AA} and R=560), in visitor mode (PI: C. Tortora, ID: 17AN005). See Section 3.1.
20 spectra of UCMG candidates have been collected using the Device Optimized for the Low RESolution (DOLORES) spectrograph mounted on the 3.5m TNG, during six nights in March 2017 and 2018 (PI: N.R. Napolitano,
ID: A34TAC_22 and A36TAC_20; resolution R=585 and wavelength range 4000-8000{AA}). See Section 3.2.

In addition to the 33 new UCMG candidates presented in this paper, we also apply the same kinematics procedure to the 28 UCMG candidates from Tortora+ 2018MNRAS.481.4728T
6 observed with TNG and 22 with the New Technology Telescope (NTT), which we refer to as the ucmg_tng_t18 and ucmg_ntt_t18 samples, respectively. See Sections 1 and 3.4.

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table1.dat	106	33	Integrated photometry for the 33 UCMG candidates observed within our spectroscopic program
table2.dat	105	33	Structural parameters derived running 2Dphot on g-, r-, and i-bands
table3.dat	58	33	Results of the fitting procedure on the spectra belonging to the three observational runs
table4.dat	79	28	*Results of the fitting procedure on the spectra for samples ucmg_tng_t18 and ucmg_ntt_t18
table5.dat	36	33	Photometric and spectroscopic parameters for the validation of the new UCMG candidates
table6.dat	36	28	Photometric and spectroscopic parameters for the validation of ucmg_tng_t18 and ucmg_ntt_t18 samples
tablea1.dat	94	55	*Integrated photometry for the 55 systems in the ucmg_spec sample
tablea2.dat	112	55	Structural parameters derived running 2Dphot on g-, r-, and i-bands for the ucmg_spec sample

Note on table4.dat: In addition to the 33 new UCMG candidates presented in this paper, we also apply the same kinematics procedure to the 28 UCMG candidates from Tortora+ 2018MNRAS.481.4728T
6 observed with TNG and 22 with the New Technology Telescope (NTT), which we refer to as the ucmg_tng_t18 and ucmg_ntt_t18 samples, respectively (see Sections 1 and 3.4).
Note on tablea1.dat: In order to quantify the impact of the systematics on the
UCMG selection, we have created (in Section 4.2) the ucmg_spec sample: a sample of 55 UCMGs with spectroscopic redshifts from the literature, similar to the sample used in Tortora+ 2018MNRAS.481.4728T, but selected with the new mass setup. We have gathered these spectroscopic redshifts from SDSS (see DR9, V/139 and DR10, 2014ApJS..211...17A),

GAMA (Driver+ 2011, J/MNRAS/413/971), which overlap the KiDS fields in the Northern cap, and 2dFLenS (Blake+ 2016MNRAS.462.4240B), observed in the Southern hemisphere.

See also:
 B/eso : ESO Science Archive Catalog (ESO, 1991-2021)
 II/347 : KiDS-ESO-DR3 multi-band source catalog (de Jong+, 2017)
 V/139 : The SDSS Photometric Catalog, Release 9 (Adelman-McCarthy+, 2012)
 J/ApJ/720/723   : Compact galaxies in the local universe (Taylor+, 2010)
 J/MNRAS/404/1639 : MILES base models & new line index system (Vazdekis+, 2010)
 J/ApJ/739/L44   : Structural data for gal. between 0.2<z<2.7 (Damjanov+, 2011)
 J/MNRAS/413/971 : Galaxy And Mass Assembly (GAMA) DR1 (Driver+, 2011)
 J/ApJ/762/77   : PM2GC mass-limited sample surface phot. (Poggianti+, 2013)
 J/ApJ/793/39   : Sp. properties of BOSS compact galaxies (Damjanov+, 2014)
 J/MNRAS/452/2087 : Galaxy And Mass Assembly (GAMA): DR2 (Liske+, 2015)
 J/A+A/578/A134   : Compact early-type galaxies in SDSS (Saulder+, 2015)
 J/ApJS/218/10   : HET Massive Galaxy Survey (HETMGS) (van den Bosch+, 2015)
 J/A+A/632/A34   : KiDS+VIKING-450 opt+NIR dataset (Wright+, 2019)

Byte-by-byte Description of file: table1.dat

Bytes	Format	Units	Label	Explanations
1- 7	A7	"Y/M"	Date	Date of observation (UT)
9- 19	A11	---	Inst	Instrument (1)
21- 22	I2	---	Seq	[1/33] Running sequence number
24- 27	A4	---	---	[KIDS]
29- 48	A20	---	KIDS	Name (JHHMMSS.ss+DDMMSS.ss)
50- 54	F5.2	---	rmagA	[18.56/19.96] r-band KiDS MAG_AUTO
56- 60	F5.2	mag	umag	[20.4/24.6] KiDS 6" aperture u-band magnitude (G1)
62- 65	F4.2	mag	e_umag	[0.02/1.76] Uncertainty on the umag
67- 71	F5.2	mag	gmag	[19.9/21.5] KiDS 6" aperture g-band magnitude (G1)
73- 77	F5.3	mag	e_gmag	[0.006/0.2] Uncertainty on the gmag
79- 83	F5.2	mag	rmag	[18.58/20] KiDS 6" aperture r-band magnitude (G1)
85- 89	F5.3	mag	e_rmag	[0.002/0.04] Uncertainty on the rmag
91- 95	F5.2	mag	imag	[18.1/19.5] KiDS 6" aperture i-band magnitude (G1)
97- 101	F5.3	mag	e_imag	[0.005/0.08] Uncertainty on the imag
103- 106	F4.2	---	zphot	[0.22/0.45] Photometric redshift from machine learning

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Note (1): Instrument as follows:
    INT/IDS   = the 2.54m Isaac Newton Telescope (13 occurrences)
    TNG/DOLORES = the 3.6m Telescopio Nazionale Galileo (20 occurrences)

Byte-by-byte Description of file: table2.dat

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--------------------------------------------------------------------------------
   Bytes Format Units   Label   Explanations
--------------------------------------------------------------------------------
  1-   2 I2     ---     Seq     [1/33] Running sequence number
  4-   7 F4.2   arcsec  Radg    [0.06/0.7] g-band circularized effective
radius,
                                {theta}_e_
  9-  12 F4.2   kpc     Reffg   [0.3/3.1] g-band circularized effective
radius
 14-  18 F5.2   ---     ng      [1.5/10.1] g-band Sersic index
 20-  23 F4.2   ---     qg      [0.1/0.99] g-band axis ratio
 25-  28 F4.2   ---     Chi2g   [0.99/1.1] {chi}^2^ of the surface
photometry
                                fit in g-band
 30-  33 F4.2   ---     Chir2g  [0.9/1.4] {chi}^2^ of the surface
photometry
                                fit including only central pixels in g-
band
 35-  37 I3     ---     SNRg    [36/161] signal-to-noise ratio S/N of the
                                photometric g-band images (G2)
 39-  42 F4.2   arcsec  Radr    [0.06/0.4] r-band circularized effective
radius,
                                  {theta}_e_
 44-  47 F4.2   kpc     Reffr   [0.35/1.55] r-band circularized effective
radius
 49-  52 F4.2   ---     nr      [2.15/9.54] r-band Sersic index
 54-  57 F4.2   ---     qr      [0.2/0.9] r-band axis ratio
 59-  62 F4.2   ---     Chi2r   [0.98/1.15] {chi}^2^ of the surface
photometry
                                  fit in r-band
 64-  67 F4.2   ---     Chir2r  [0.9/2.8] {chi}^2^ of the surface
photometry
                                  fit including only central pixels in r-
band
 69-  71 I3     ---     SNRr    [36/421] signal-to-noise ratio S/N of the
                                  photometric r-band images (G2)
 73-  76 F4.2   arcsec  Radi    [0.1/0.7] i-band circularized effective
radius,
                                  {theta}_e_
 78-  81 F4.2   kpc     Reffi   [0.45/2.6] i-band circularized effective
radius
 83-  86 F4.2   ---     ni      [2.1/9.16] i-band Sersic index
 88-  91 F4.2   ---     qi      [0.04/0.87] i-band axis ratio
 93-  96 F4.2   ---     Chi2i   [0.97/1.1] {chi}^2^ of the surface
photometry
                                  fit in i-band
 98- 101 F4.2   ---     Chir2i  [0.87/1.1] {chi}^2^ of the surface
photometry
                                  fit including only central pixels in i-
band
103- 105 I3     ---     SNRi    [62/244] signal-to-noise ratio S/N of the
                                  photometric i-band images (G2)
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Byte-by-byte Description of file: table[34].dat
--------------------------------------------------------------------------------
   Bytes Format Units    Label  Explanations
```

```
--------------------------------------------------------------------------------
   1-  2 I2     ---      Seq    [1/61] Running sequence number
   4-  7 F4.2   ---      zphot  [0.2/0.45] Photometric redshift
   9- 14 F6.4   ---      zspec  [0.15/0.47] Measured spectroscopic redshift
  16- 21 F6.4   ---    e_zspec  [0.0001/0.006] zspec uncertainty
  23- 25 I3     km/s     sigma  [142/432] Velocity dispersion
  27- 29 I3     km/s   e_sigma  [22/113] sigma uncertainty
  31- 33 I3     ---      sige   [149/464] The corrected velocity dispersion
to
                                the effective radius, {sigma}_e_
  35- 38 F4.2   arcsec   Ap     [0.69/1.6] The circular aperture
  40- 43 F4.2   ---      SR     [0.02/1] The success rate (ratio between
the
                                number of accepted fits over the total 257
                                attempts)
  45- 49 F5.2   ---      SNRsp  [1.39/15.1] The signal-to-noise ratio per
pixel
                                calculated in the range 3600-4600{AA}
  51- 55 F5.2   ---      SNRk   [2/24.6] The signal-to-noise ratio per
pixel
                                calculated over the region used for the
fit by
                                OMEGA-K
  57- 58 A2     ---      Qual   The quality level of the velocity
dispersion
                                estimates (2)
  60- 79 A20    ---      KIDS   KiDS identifier (JHHMMSS.ss+DDMMSS.ss)
                                for Tortora+ 2018MNRAS.481.4728T sample;
                                column added by CDS
--------------------------------------------------------------------------------
Note (2):  Quality level of the velocity dispersion as follows:
    HQ = high-quality if SR>=0.3, SNRsp>=3.5, and SNRk>=6.5/px;
    LQ = low-quality

           See Section 3.4.
--------------------------------------------------------------------------------

Byte-by-byte Description of file: table[56].dat
--------------------------------------------------------------------------------
   Bytes Format Units   Label   Explanations
--------------------------------------------------------------------------------
   1-  2 I2     ---     Seq     [1/61] Running sequence number
   4-  7 F4.2   ---     zphot   [0.2/0.45] Photometric redshift
   9- 12 F4.2   ---     zspec   [0.16/0.47] Spectroscopic redshift
  14- 17 F4.2   kpc     Reffp   [0.35/1.5] Median effective radius,
photometric
  19- 22 F4.2   kpc     Reffsp  [0.28/1.81] Median effective radius,
                                spectroscopic
  24- 28 F5.2  [Msun]   Massp   [10.7/11.4] Stellar mass, photometric
  30- 34 F5.2  [Msun]   Masssp  [10.46/11.5] Stellar mass, spectroscopic
      36 A1     ---     Valid   Spectral validation (3)
--------------------------------------------------------------------------------
Note (3): Spectral validation as follows:
    Y = confirmed UCMG (i.e., log_10_(M_*_/M_{sun}_)>10.9 and R_e_<1.5kpc)
    N = candidate is not a confirmed UCMG
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Byte-by-byte Description of file: tablea1.dat
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   Bytes Format Units  Label  Explanations
--------------------------------------------------------------------------------
-----
   1-  3 A3     ---    ID     Identifier
   5-  8 A4     ---    ---    [KIDS]
  10- 29 A20    ---    KIDS   Name (JHHMMSS.ss+DDMMSS.ss)
  31- 35 F5.2   mag    rmagA  [17/20.94] r-band KiDS MAG_AUTO
  37- 41 F5.2   mag    umag   [19.2/24.9] KiDS 6" aperture u-band magnitude
(G1)
  43- 46 F4.2   mag  e_umag   [0.01/1.76] Uncertainty on the umag
  48- 52 F5.2   mag    gmag   [17.9/22.6] KiDS 6" aperture g-band magnitude
(G1)
  54- 58 F5.3   mag  e_gmag   [0.002/0.06] Uncertainty on the gmag
  60- 64 F5.2   mag    rmag   [17/20.91] KiDS 6" aperture r-band magnitude
(G1)
  66- 71 F6.4   mag  e_rmag   [0.0008/0.01] Uncertainty on the rmag
  73- 77 F5.2   mag    imag   [16.7/20.2] KiDS 6" aperture i-band magnitude
(G1)
  79- 83 F5.3   mag  e_imag   [0.001/0.04] Uncertainty on the imag
  85- 88 F4.2   ---    zphot  [0.11/0.48] Photometric redshift
  90- 94 F5.2  [Msun]  Mass   [10.58/11.3] Stellar mass
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Byte-by-byte Description of file: tablea2.dat
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  Bytes Format Units   Label   Explanations
--------------------------------------------------------------------------------
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  1-  3  A3    ---     ID      Identifier
  5-  8 F4.2   arcsec  Radg    [0.05/0.81] g-band circularized effective
radius,
                                {theta}_e_
 10- 13 F4.2   kpc     Reffg   [0.24/4.9] g-band circularized effective
radius
 15- 19 F5.2   ---     ng      [0.69/10.6] g-band Sersic index
 21- 24 F4.2   ---     qg      [0.12/0.92] g-band axis ratio
 26- 29 F4.2   ---     Chi2g   [0.83/1.2] {chi}^2^ of the surface
photometry
                                fit in g-band
 31- 35 F5.2   ---     Chir2g  [0.86/11.6] {chi}^2^ of the surface
photometry
                                fit including only central pixels in g-
band
 37- 39 I3     ---     SNRg    [16/602] Signal-to-noise ratio S/N of the
                                photometric g-band images (G2)
 41- 44 F4.2   arcsec  Radr    [0.09/0.64] r-band circularized effective
radius,
                                {theta}_e_
 46- 49 F4.2   kpc     Reffr   [0.48/2] r-band circularized effective
radius
 51- 55 F5.2   ---     nr      [1.99/10.64] r-band Sersic index
 57- 60 F4.2   ---     qr      [0.17/0.89] r-band axis ratio
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 62- 65 F4.2   ---     Chi2r   [0.98/1.5] {chi}^2^ of the surface
photometry
                                fit in r-band
 67- 71 F5.2   ---     Chir2r  [0.98/25.8] {chi}^2^ of the surface
photometry
                                fit including only central pixels in r-
band
 73- 76 I4     ---     SNRr    [74/1109] signal-to-noise ratio S/N of the
                                photometric r-band images (G2)
 78- 81 F4.2   arcsec  Radi    [0.1/1.3] i-band circularized effective
radius,
                                {theta}_e_
 83- 86 F4.2   kpc     Reffi   [0.4/6] i-band circularized effective radius
 88- 92 F5.2   ---     ni      [1/10.1] i-band Sersic index
 94- 97 F4.2   ---     qi      [0.17/0.9] i-band axis ratio
 99-102 F4.2   ---     Chi2i   [0.98/1.1] {chi}^2^ of the surface
photometry
                                fit in i-band
104-108 F5.2   ---     Chir2i  [0.86/11.1] {chi}^2^ of the surface
photometry
                                fit including only central pixels in i-
band
110-112 I3     ---     SNRi    [32/641] signal-to-noise ratio S/N of the
                                photometric i-band images (G2)
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Globale notes:
Note (G1): All the magnitudes have been corrected for Galactic extinction
    using Schlafly & Finkbeiner (2011ApJ...737..103S) maps.
Note (G2): The signal-to-noise ratio S/N of the photometric images, defined
    as the inverse of the error on MAG_AUTO.
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History:
    From electronic version of the journal

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(End)                                       Emmanuelle Perret [CDS]   04-
Oct-2021
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