The complex multi-component outflow of the Seyfert galaxy NGC 7130 (Corrigendum)

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This is a corrigendum to Comerón et al. (2021). Due to a mistake in our codes, all line fluxes were multiplied by a factor of 1.25. This affects the colour scales in two figures and the physical magnitudes derived from the flux in H β , namely the gas mass outflow rate, the kinetic power of the outflow, and the fraction of the active galactic nucleus (AGN) power that is emitted in the form of kinetic energy. The conclusions of the paper remain unchanged. The corrected figures, tables, and relevant portions of the text are given below.

4.8. The mass outflow rate and the kinetic power

The mass-loss rates and kinetic power estimates for each of the outflow components are shown in Table 6. We find a total mass loss rate of $\dot{M} = 0.44 \pm 0.27 M_{\odot} \text{ yr}^{-1}$ and

a total kinetic power of $\dot{E}_{\text{kin}} = (7.0 \pm 4.8) \times 10^{40} \text{ erg s}^{-1}$ for the blueshifted components. If we also account for the more poorly constrained redshifted components, these values are $\dot{M} = 1.2 \pm 0.7 M_{\odot} \text{ yr}^{-1}$ and $\dot{E}_{\text{kin}} = (2.7 \pm 2.0) \times 10^{41} \text{ erg s}^{-1}$, respectively. The latter values have to be considered with caution because a third of the mass-loss rate and two-thirds of the kinetic power come from the redshifted broad component that is hard to characterise. Indeed, we might only be detecting it over a small fraction of its true extent, which can cause a large overestimate in its associated mass-loss rate and kinetic power (through Eq. (9)). Assuming a bolometric AGN luminosity of $L_{\text{bol}} = 2.2 \times 10^{44} \text{ erg s}^{-1}$ (Esquej et al. 2014, we corrected the luminosity for the different distance estimates), the fraction of power emitted in kinetic energy is $F_{\text{kin}} = 0.032 \pm 0.022\%$ for the blueshifted

Table 6. Average physical properties of kinematic components of the ionised gas.

Component	BPT classification	n_e (cm^{-3})	$E(B - V)$	[S III]/[S II]	$L(\text{H}\beta)_{\text{corr}}$ ($10^{39} \text{ erg s}^{-1}$)	$\dot{M}$ ($M_{\odot} \text{ yr}^{-1}$)	$\dot{E}_{\text{kin}}$ ($10^{39} \text{ erg s}^{-1}$)
Disc	SF	90 ± 20	0.60 ± 0.01	0.385 ± 0.008	235 ± 5	–	–
Blueshifted narrow	Seyfert	500 ± 100	0.34 ± 0.04	1.20 ± 0.08	27 ± 1.9	0.05 ± 0.03	1.2 ± 1.1
Zero-velocity narrow	SF + AGN	500 ± 400	0.53 ± 0.11	0.68 ± 0.15	15 ± 3	–	–
Crescent narrow	LINER	180 ± 20	0.78 ± 0.01	0.134 ± 0.003	3.9 ± 0.1	0.09 ± 0.04	3.0 ± 2.1
Redshifted narrow 1	Seyfert	$500 \pm 100^{(*)}$	0.56 ± 0.13	2.7 ± 0.7	8 ± 2	0.09 ± 0.05	2.9 ± 3.0
Redshifted narrow 2	Seyfert	$500 \pm 100^{(*)}$	0.57 ± 0.11	0.9 ± 0.3	6.2 ± 1.4	0.16 ± 0.10	25 ± 19
Blueshifted broad	Seyfert	300 ± 100	0.46 ± 0.03	1.27 ± 0.07	57 ± 3	0.39 ± 0.24	69 ± 47
Zero-velocity broad	Seyfert	$300 \pm 100^{(*)}$	0.80 ± 0.28	0.9 ± 0.5	23 ± 13	–	–
Redshifted broad	Seyfert	$300 \pm 100^{(*)}$	$0.57 \pm 0.11^{(*)}$	$1.27 \pm 0.07^{(*)}$	1.8 ± 0.4	0.41 ± 0.26	170 ± 130

Notes. Error estimates are calculated by propagating the uncertainties quoted in Table 6 and Sects. 4.7 and 4.8 in quadrature. Values indicated by asterisks (*) do not come from measurements, but are instead educated guesses used for our calculations (see Sects. 4.7 and 4.8).

Fig. 10. Surface brightness of [O III] $\lambda 5007$ emission of the nine kinematically identified components.

components and $F_{\text{kin}} = 0.12 \pm 0.09\%$ if accounting for all components.

Fig. 11. [O III] $\lambda 5007$ surface brightness of blueshifted narrow component (same map as in the corresponding panel in Fig. 10). The black line overlay shows the VLA 8.4 GHz continuum data obtained for Thean et al. (2000) as processed by Zhao et al. (2016). The contour levels cover a range from 0.001 to 0.007 mJy beam⁻¹ in steps of 0.001 mJy beam⁻¹. The angular resolution in radio is 0′′.60 × 0′′.19 and the position angle of the point spread function ellipse is $\sim 10^\circ$ (Zhao et al. 2016).

5. Discussion

We estimated the mass outflow rates and kinetic power for each of the outflow components separately. We find that, although both narrow and broad outflow components have virtually the same flux in H β ($L(\text{H}\beta)_{\text{corr}} \sim (40\text{--}60) \times 10^{39} \text{ erg s}^{-1}$), the broad components carry $\sim 2/3$ of the mass outflow and maybe as much as $\sim 90\%$ of the kinetic power. If we consider only the blueshifted components, which are better constrained due to the reduced extinction, we find that the luminosities of the narrow and the broad components are comparable ($L(\text{H}\beta)_{\text{corr}} \approx 30 \times 10^{39} \text{ erg s}^{-1}$ and $L(\text{H}\beta)_{\text{corr}} \approx 60 \times 10^{39} \text{ erg s}^{-1}$, respectively). In this case, the broad component carries 90% of the mass loss and almost all the kinetic power (98%). The relatively modest energy output of the ionised gas outflow, compared to the bolometric luminosity of the AGN ($F_{\text{kin}} \approx 0.12\%$ when accounting for all the components, and $F_{\text{kin}} \approx 0.03\%$ when accounting only for the blueshifted components), makes it unlikely that it has a significant impact on a galaxy-wide scale (see discussion in Villar-Martín et al. 2016). The mass-loss rate ($\dot{M} = 1.2 \pm 0.7 M_\odot \text{ yr}^{-1}$ for all the components and $\dot{M} = 0.44 \pm 0.27 M_\odot \text{ yr}^{-1}$ for the blueshifted components) is also low compared to the star formation rate, which is estimated to be $\dot{M}_{\text{SFR}} = 20.93 \pm 0.05 M_\odot \text{ yr}^{-1}$ (Gruppioni et al. 2016) or $\dot{M}_{\text{SFR}} = 6.7 M_\odot \text{ yr}^{-1}$ (Diamond-Stanic & Rieke 2012) for the galaxy as a whole, and $\dot{M}_{\text{SFR}} = 4.3 M_\odot \text{ yr}^{-1}$ for the innermost kiloparsec (Diamond-Stanic & Rieke 2012).

6. Summary and conclusions

We have measured the ionised gas mass outflow rate and the kinetic power of the outflow (Sect. 4.8). Accounting for all the components (the blueshifted components), we find them to

be $\dot{M} = 1.2 \pm 0.7 M_{\odot} \text{ yr}^{-1}$ ($\dot{M} = 0.44 \pm 0.27 M_{\odot} \text{ yr}^{-1}$) and $\dot{E}_{\text{kin}} = (2.7 \pm 2.0) \times 10^{41} \text{ erg s}^{-1}$ ($\dot{E}_{\text{kin}} = (7.0 \pm 4.8) \times 10^{40} \text{ erg s}^{-1}$), respectively. The kinetic power is $F_{\text{kin}} = 0.12 \pm 0.09\%$ ($F_{\text{kin}} = 0.032 \pm 0.022\%$) of the bolometric AGN output. These values are comparable to those of other AGN (Villar-Martín et al. 2016; Rose et al. 2018) and are roughly a factor of ten lower than the star formation rate. They are probably too low for the outflow to have a galaxy-wide effect. The broad outflow components are responsible for $\sim 2/3$ ($\sim 90\%$) of the mass outflow rate and about 90% (98%) of the kinetic power output.

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