Theoretical models and numerical simulations have established a framework of galaxy evolution in which galaxies merge and create dual supermassive black holes (with separations of one to ten kiloparsecs), which eventually sink into the centre of the merger remnant, emit gravitational waves and coalesce. The merger also triggers star formation and supermassive black hole growth, and gas outflows regulate the stellar content. Although this theoretical picture is supported by recent observations of starburst-driven and supermassive black hole-driven outflows, it remains unclear how these outflows interact with the interstellar medium. Furthermore, the relative contributions of star formation and black hole activity to galactic feedback remain unknown. Here we report observations of dual outflows in the central region of the prototypical merger NGC 6240. We find a black-hole-driven outflow of [O III] to the northeast and a starburst-driven outflow of Hα to the northwest. The orientations and positions of the outflows allow us to isolate them spatially and study their properties independently. We estimate mass outflow rates of 10 and 75 solar masses per year for the Hα bubble and the [O III] cone, respectively. Their combined mass outflow is comparable to the star formation rate, suggesting that negative feedback on star formation is occurring.

NGC 6240 is an ideal system in which to study the effects of winds on the evolution of a galaxy. Its high star formation rate (SFR > 100 M☉ yr⁻¹, as determined by ultraviolet and infrared luminosity measurements), and the presence of a dual active galactic nucleus (AGN) with a separation of about 0.7 kpc (bolometric luminosities of 8 × 10^44 erg s⁻¹ and 2.6 × 10^44 erg s⁻¹ for the southwestern and northeastern nuclei, respectively) ensure ample activity for driving substantial feedback. A nebula with bright optical emission lines is known to be associated with NGC 6240. At scales smaller than 10 kpc, Chandra observations have revealed that the central Hα nebula (the "butterfly nebula") is spatially coincident with the soft X-ray-emitting gas surrounding the dual AGN. Such good spatial correlation indicates that the hot and warm phases of the interstellar medium in the butterfly nebula are excited via the same mechanism (probably shocks caused by outflowing gas). In addition, Hα emission extends to about 90 kpc and shows multiple loops, bubbles and filaments. Previous studies have suggested that the extended Hα nebula is primarily excited by shock heating induced by a starburst-driven supernova. However, the kinematics of the butterfly nebula has not been studied in detail because high-spatial-resolution observations are needed to separate the two nuclei and identify small-scale kinematic structures.

In this work we use Hubble Space Telescope (HST) imaging and spectroscopic data from the ground-based long-slit Dual Imaging Spectrograph at the Apache Point Observatory (APO/DIS) and the integral-field Spectrograph for Integral Field Observations in the Near-Infrared at the Very Large Telescope (VLT/SINFONI; see Methods) to determine the morphology and kinematics of the low-ionization (Brγ and Hα) and high-ionization gas ([O III] at wavelength λ = 5,007 Å; hereafter, [O III]), in the butterfly-shaped inner region of NGC 6240. The HST images reveal the detailed structure of the narrow-line region in NGC 6240 (as traced by the [O III]-emitting gas, which is less affected by star formation than Hα or Brγ) and allow us to ascertain whether the contribution of the dual AGN in the formation of outflowing winds is substantial.

In Fig. 1 we present a three-colour composite image of the central 25'' × 25'' of NGC 6240, obtained with Wide Field Camera 3 (WFC3) of the HST. Green corresponds to the continuum (filter F621M, with a central wavelength of 6,200 Å), red to Hα (filter F673N) and blue to [O III] (FQ508N) emission. The inset of Fig. 1, we summarize the relevant morphological structures. In all WFC3 images there are two emission peaks, which are located at the positions of the two AGNs, whereas most of the continuum emission is in the disk of the merger remnant. Therefore, the extended emission in the F621M image traces the stellar continuum. The prominent dark dust lane running along the northeast–southwest direction is also spatially coincident in the three WFC3 images.

The F673N image reveals filaments and bubbles of Hα emission to both the east and west of the nuclei. The bubbles do not appear to be coincident with the stellar continuum, which suggests that they result from winds, rather than gas associated with tidal debris. Furthermore, the bubbles and filaments to the west of the nuclei are seen mostly in Hα (regions 2 and 4). This emission is probably due to shock ionization from stellar winds (see Methods). On the other side of the nuclei, to the east/southeast of the southwestern nucleus (region 3), knots and filaments are seen in both Hα and [O III], consistent with a scenario in which both the dual AGN and star formation contribute to the ionization of the extraplanar gas. In addition to region 3, the FQ508N image also reveals diffuse [O III] emission in some parts of the galactic disk and an extended extraplanar structure with conical geometry to the northeast of the nuclei (region 1), which is faint to non-existent in Hα. The [O III] gas in region 1 is not spatially correlated with the stellar continuum (Fig. 1) or with the molecular gas (Extended Data Fig. 2), which indicates that this structure is not associated with tidal tails from the merger. These four observations, as well as the similarity between the morphology of the [O III] emission (which extends to a distance of 3.7 kpc to the northeast with an opening angle θ_out ≈ 50°; see Extended Data Fig. 1) with ionization cones seen in prototypical Seyfert galaxies, suggest that the gas in region 1 is mostly ionized by the AGN. This interpretation is supported by optical emission-line diagnostics (see Methods). Most of the points in the [O III] cone lie in the Seyfert or LINER (low-ionization nuclear-emission-line region), rather than in the starburst (H II) region, on the Baldwin–Phillips–Terlevich (BPT) diagram (Extended Data Fig. 3), with 20% (3 out of 15) of the spatial elements located in the Seyfert region. In addition, the [O III] / Hβ ratio is considerably enhanced in region 1, reaching a maximum of about 10 (the largest in the butterfly nebula), placing the [O III] cone firmly in the Seyfert region. This behaviour is not observed in any other part of the galaxy and suggests a substantial contribution from AGN photoionization. Because LINERs do not usually show ionization cones of highly ionized gas, the [O III] cone is probably produced by the southwestern nucleus, which is also the most powerful of the...
two AGNs in the system. However, we cannot rule out a contribution from the northeastern nucleus. The location of the [O III] cone (next to the northeastern nucleus) and the fact that the apparent base of the cone encompasses both nuclei suggest a combined narrow-line region from the two AGNs.

Figure 2 shows the SINFONI velocity map of ionized hydrogen (Brγ) overlaid on the Hα HST image. The velocity maps of the stars and molecular hydrogen (H2) are also shown for comparison. While two rotational components are observed in the stellar kinematics, the H2 velocity map shows one large perturbed rotating disk with a rotation axis that is not aligned with those of the two nuclei. The decoupled H2 disk is probably produced by the tidal forces of the interaction and its sense of rotation follows the orbital history of the merger. The rotational velocity of the H2 disk is about 220 km s\(^{-1}\). Interestingly, the kinematics of the low-ionization gas is considerably different from both that of stars and that of H2. Redshifted velocities of 360 km s\(^{-1}\) and broad emission lines (velocity dispersion \(\sigma \approx 450\) km s\(^{-1}\)) are observed in the northeastern nucleus at the base of the H\(\alpha\) bubble (Extended Data Fig. 4), indicating an outflow of ionized hydrogen (see Methods).

Position–velocity diagrams of the [O III] emission in region 1 reveal the typical signatures of outflows (Fig. 3): (i) high-velocity (up to 350 km s\(^{-1}\)) components that cannot be explained by the same gravitational potential that produces H\(\alpha\) velocities of about 220 km s\(^{-1}\) in the galaxy disk (Fig. 2), (ii) broad components of [O III] (\(\sigma \approx 1,070\) km s\(^{-1}\)) and (iii) signatures of radial acceleration and deceleration. These features support the hypothesis of a non-gravitational force accelerating the gas from about 0 km s\(^{-1}\) at the centre of the galaxy (between the two nuclei; see Extended Data Fig. 1) to about 350 km s\(^{-1}\) at a distance \(r = 1.8\) kpc and subsequently decelerating it to about 190 km s\(^{-1}\) at \(r = 3.7\) kpc (Fig. 3).

The morphology, kinematics, timescale and energetics of the [O III] cone are consistent with energy injection from the AGN (see Methods). In particular, the kinetic power of the outflow is about 2.9 times larger than the estimated injection of energy from the nuclear starburst (assuming SFR \(= 100 M_\odot\) yr\(^{-1}\), requiring a substantial contribution from the AGN. On the other hand, the timescale of the H\(\alpha\) bubble (7.4 Myr) and its energetics are consistent with energy injection from a recent episode of star formation that started less than 9 Myr ago. This timescale is inconsistent with the typical AGN flickering cycles but agrees with the age of the nuclear starburst in NGC 6240.

The AGN-driven outflow carries about 7.5 times more mass (\(M_{\text{AGN}} \approx 75 M_\odot\) yr\(^{-1}\)) and is about 15 times more powerful (higher kinetic luminosity, \(E_{\text{AGN}} \approx 2 \times 10^{44}\) erg s\(^{-1}\)) than the outflow in the H\(\alpha\) bubble (\(M_{\text{bubble}} \approx 10 M_\odot\) yr\(^{-1}\), \(E_{\text{bubble}} \approx 1.3 \times 10^{43}\) erg s\(^{-1}\)). We note that \(M_{\text{bubble}}\) does not correspond to the total outflow rate due to star formation (\(M_{\star}\)) in the nuclear region; regions 3 and 4 also need to be included. Assuming the same properties of the H\(\alpha\) bubble (geometry, kinematics and mass) for regions 3 and 4 (Fig. 1; see also refs 14 and 15), \(M_{\star}\) would be about 30 \(M_\odot\) yr\(^{-1}\). We use the ratio of the mass outflow rate to the SFR to evaluate the influence of negative feedback on the newly formed galaxy disk. A value smaller than 1 indicates that the outflow does not carry enough mass to affect the stellar production considerably. If this ratio is equal to or greater than 1, negative feedback on star formation is occurring. In NGC 6240 the combined effect of...
Fig. 2 | VLT/SINFONI maps of NGC 6240. a, Stellar velocity. b, H$_2$ velocity map. c, Velocity map of Br$\gamma$ overlaid on the HST image of H$_\alpha$. In all panels, the contours delineate the K-band continuum emission and are spaced at 10% of the peak flux. Although two rotational components are observed in the stellar kinematics, the H$_2$ kinematics shows one perturbed rotational component with a kinematic major axis oriented at a position angle of 22°. The Br$\gamma$ kinematics of the northeastern nucleus is dominated by non-circular motions. Redshifted velocities of 360 km s$^{-1}$ are observed at the base of the H$_2$ bubble. In all maps, north is up and east is to the left. RA, right ascension; Dec., declination. The colour bar indicates line-of-sight velocity ($V_{\text{LOS}}$).

$M_{\text{AGN}}$ and $M_{\text{SF}}$ is comparable to the SFR$^{10}$. Therefore, we are witnessing the crucial phase in the evolution of mergers of gas-rich galaxies in which suppression of star formation is starting to occur. It is important to note that the starburst-driven outflow alone underestimates the effect of feedback in the galaxy (a similar conclusion is reached for the AGN-driven outflow). Only the combined mass outflow rate can limit

Fig. 3 | Kinematics of [O III]. a, b, Segments of the two-dimensional long-slit spectra of NGC 6240, centred at the rest wavelength of [O III]. The colour scale represents flux density normalized to the peak. Cool colours (green and blue) correspond to background emission (<10% of the peak emission). Warm colours (yellow to red) correspond to sizeable flux density values (>10% of the peak of emission). c, d, Position–velocity diagrams of [O III] and H$_2$ emission, where $v$ is the velocity and $\sigma$ is the velocity dispersion. The galaxy was observed at two position angles, 22° and 56° (see also Extended Data Fig. 1). Positive values of angular distance (vertical axis in a and b and horizontal axis in c and d) correspond to the direction north from the centre of the galaxy, at the marked position angle. The number of spatial elements extracted from our long-slit observations (a, b) is 27 at PA$_1$ = 22° (c) and 34 at PA$_2$ = 56° (d). There are 15 spatial elements inside the [O III] cone (between 0° < $r$ < 7′′ in d). We extracted the velocity and dispersion values for H$_2$ at 7 different spatial positions along imaginary APO/DIS long slits oriented at 22° and 56° in the SINFONI data (Fig. 2).
the star formation activity and the growth of the newly formed galaxy after the merger event.

**Online content**

Any Methods, including any statements of data availability and Nature Research reporting summaries, along with any additional references and Source Data files, are available in the online version of the paper at https://doi.org/10.1038/s41586-018-0033-2.

Received: 5 July 2017; Accepted: 4 January 2018; Published online 18 April 2018.

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**Acknowledgements**

Some of the data presented in this paper were obtained from the Mikulski Archive for Space Telescopes (MAST). The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS5-26555. The optical spectroscopic data reported here were obtained at the Apache Point Observatory 3.5-m telescope, which is owned and operated by the Astrophysical Research Consortium. F.M.-S. acknowledges financial support from NASA HST Grant HST-AR-13260. G.C.P. acknowledges support from a FONDECYT Postdoctoral Fellowship (number 3150361) and the University of Florida. E.T. acknowledges support from CONICYT Anillo ACT1101, FONDECYT regular grants 1120061 and 1160999, and Basal-CATA PFB-06/2007.

**Author contributions**

F.M.-S. conceived the project, analysed the data, coordinated the activities and prepared the manuscript. R.N. prepared and reduced the APO/DIS observations and created the BPT diagrams. F.M.-S. and J.C. analysed the HST images. R.D. reduced the VLT/SINFONI data. E.T. and G.C.P. contributed to the analyses and discussion. All authors discussed the results and implications and commented on the manuscript at all stages.

**Competing interests**

The authors declare no competing interests.

**Additional information**

Extended data is available for this paper at https://doi.org/10.1038/s41586-018-0033-2.

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METHODS
HST imaging. NGC 6240 was observed by the WFC3 on 2 August 2012 (program GO-12552; principal investigator, L. Kewley). The HST/WFC3 data provide high-resolution (0.0396 Å per pixel) optical imaging in five narrow-band and two medium-band filters (WFC3-UVIS channel). In this work, we selected the filters FQ508N and F673N as tracers of the high-ionization ([O II]) and low-ionization (Hβ) gas, respectively. At the redshift of NGC 6240 (z = 0.0245), these filters entirely cover the [O II] and Hβ emission. Blue (F621M) and red (F621M) continuum images were also used to trace the emission of the stars in the system. We used continuum-subtracted [O II] and Hβ images for the analysis. To obtain an image of the ionized gas emission ([O II] and Hβ), we aligned the off-band image with the on-band one, scaled it to fit the on-band image at radii where the ionized gas flux is negligible, and subtracted it from the on-band image.

Near-infrared adaptive-optics-assisted integral-field spectroscopy. The integral-field data of NGC 6240 used in this work are VLT/SINFONI observations34,35 obtained on the night of 20 August 2007 (programme 079.B-0576). Details of the observations and data reduction have been described in a previous publication.30 The final datacube has a spatial resolution of 0.097′′ × 0.162′′ full-width at half-maximum (using a pixel scale of 0.05′′ per pixel and a field of view of 3.6′′ × 4.0′′) and a spectral resolution of about 90 km s$^{-1}$ full-width at half-maximum in the K-band. We derived the two-dimensional properties (flux and velocity maps) of the gas and the stars using the IDL code LINEFIT33, which estimates the uncertainties in the Gaussian fits using Monte Carlo techniques. This method fits the emission lines (absorption features) by convolving a Gaussian with a spectrally unresolved template profile (a sky line for emission lines and a template stellar spectrum for stellar absorption features) to the continuum-subtracted spectral profile at each spatial pixel in the datacube. The velocities are measured relative to the systemic redshift of the galaxy, taking into account the stellar kinematics the 50 km s$^{-1}$ redshift of the northeastern nucleus with respect to the southwestern nucleus25,30. Several realizations (usually 100) of the data are generated by adding random noise to the flux at each pixel; these are fitted using the same procedure as above. This method allowed us to obtain uncertainties for the kinematic maps in the range 40–400 km s$^{-1}$.

In Extended Data Fig. 1 we show (i) the location and velocity of the 360 km s$^{-1}$ component with the systemic velocity of the galaxy. These extremely broad lines suggest that the nebular emission in region 4 is dominated by star formation.

Evidence of outflows in the [O III] cone. Several pieces of evidence suggest that the kinematics of the Hβ bubble is dominated by outflows. First, the ionized gas (Brγ) in the northeastern nucleus exhibits line-of-sight velocities of 360 km s$^{-1}$, which are too high to be explained by the same gravitational potential that is producing rotational star velocities of 200 km s$^{-1}$ in this nucleus (Fig. 2). Furthermore, the velocity map of Brγ is very different to that of the stars. The kinematic major axis of the stars has a position angle of about 37°, which is consistent with the photometric major axis of this nucleus (obtained from adaptive-optics images36,45). The kinematic major axis of Brγ extends in the east–west direction with a particularly fast component to the northwest (360 km s$^{-1}$) extending in the northeast (360 km s$^{-1}$), which is spatially coincident with the Hβ bubble seen in the HST images. A similar result is obtained when comparing the Brγ velocity map with that of H2. The molecular gas disk has a rotation axis (position angle 56°) that is not aligned with that of either nucleus.24,25 The H2 disk has a position angle of 22° and a redshifted velocity of 220 ± 33 km s$^{-1}$ in the northeastern nucleus. The velocity map of Brγ shows both redshifted and blueshifted velocities in this nucleus. In addition, the maximum Brγ velocity of 360 km s$^{-1}$ is consistent with the maximum rotational velocity of the molecular gas in the disk of the advanced merger (about 220 km s$^{-1}$). Finally, the gas at the base of the Hβ bubble has a very high velocity dispersion (450 ± 67 km s$^{-1}$), which can be explained only by outflows at these scales.35-45 All these results support strongly the premise of a non-gravitational force that is accelerating the gas in the northeastern nucleus to a maximum line-of-sight velocity of about 360 km s$^{-1}$ at r = 3″ (1.6 kpc) with a maximum velocity dispersion of about 450 km s$^{-1}$. These results are broadly consistent with those of a previous study51, which found a maximum line-of-sight velocity of about 400 km s$^{-1}$ for the region covered by the Hβ bubble in seeing-limited long-slit observations of NGC 6240.

Evidence for outflows in the [O III] cone. Two structural features suggest strongly the presence of outflows in the [O III] cone: (i) the location of the [O III] cone is outside the plane of rotation of the disk of the merger, in a region that is not associated with tidally structures from the galaxy merger (see Extended Data Fig. 2), and (ii) its morphology is typical of outflows seen in protostellar starburst and Seyfert galaxies34,44. Conical morphologies are not expected for inflows, which are usually radial streamers of gas16,66. These two characteristics rule out rotation or outflows as possible kinematic components of the [O III] emission in region 1.

The kinematics of the [O III] cone indicates the presence of outflows. Figure 3 shows the two-dimensional APO/DIS spectra of NGC 6240 and the kinematics (position–velocity diagrams) of [O III] extracted at the two position angles (PA1 and PA2) indicated in Extended Data Fig. 1. For comparison, we also extracted the kinematics of H2 along the directions of PA1 and PA2, matching the width of the [O III] cone. The position velocity diagrams show a broad [O III] component with a maximum line-of-sight velocity of 1,220 ± 140 km s$^{-1}$ in the central 1.5′′, with a line-of-sight velocity consistent with the systemic velocity of the galaxy. These extremely broad lines suggest the existence of an outflow that originates from the central 1.5′′ of the galaxy.
(the width of the long slit of the DIS). In addition, one clear trend emerges: the gas is more kinematically disturbed along the direction of the morphologically inferred outflow ($PA_{\text{out}} = 56^\circ$) than along the disk of the merger ($PA_{\text{disk}} = 22^\circ$). At $PA_{\text{out}} = 22^\circ$, the [O iii] emission is blueshifted by about 180 km s$^{-1}$ in the south, redshifted by about 100 km s$^{-1}$ in the north, and the emission lines are narrow ($< 250$ km s$^{-1}$), consistent with the curves of $H_2$.

By contrast, at $PA_{\text{out}} = 56^\circ$, the redshifted broad emission lines to the north provide additional information about the geometrical kinematic component. As can be seen in Fig. 3, the [O iii] velocity curve deviates considerably from that of $H_2$ at distances $r > 1$. The $H_2$ velocity reaches a maximum of 140 km s$^{-1}$ at $r = 2$. At this distance, the [O iii] velocity is about 250 km s$^{-1}$, and it continues to increase with distance, reaching a maximum velocity of $v_{\text{max}} = 350 \pm 30$ km s$^{-1}$ at $r = 3.6^\circ$. This velocity is too high to be explained by the gravitational potential of the $H_2$ disk. The maximum dispersion of [O iii] is $1.070 \pm 110$ km s$^{-1}$ at $r = 2.1^\circ$. We adopted this value as the representative velocity dispersion of the nebula because the velocity 1,220 km s$^{-1}$ at $r > 0$ might be affected by random motions caused by the merger of three components (see Extended Data Fig. 5). The outflow component begins to decelerate outside this maximum-velocity region, reaching about 190 km s$^{-1}$ at $r = 7.4^\circ$, which is an observational signature of an outflow encounter propagating from the interstellar medium. In the south region, along the direction of $PA_{\text{out}} = 56^\circ$, the [O iii] emission is faint and narrow, with line-of-sight velocities consistent with the rotation of the disk of the advanced merger (Fig. 3). Finally, the broad kinematic components in combination with the high [N ii]/H$\alpha$ ratios (characteristic of shock ionization; see Extended Data Fig. 3), provide strong evidence for the existence of outflowing gas in the [O iii] cone.

Estimation of mass outflow rates. The amount of feedback, in terms of outflowing mass entrained in the [O iii] cone and $H_2$ bubble, can be estimated using the morphometric parameters derived from the HST images and the velocities measured in our APO/DIS and VLT/SINFONI data. For the [O iii] cone, we estimate the mass outflow rate ($M_{\text{out}}$) using a method described in an earlier publication and by assuming a gas density of $n = 50$ cm$^{-3}$ and a filling factor of $f = 0.01$, which are typical of the narrow-line region at $r \approx 1.5$ kpc. The [O iii] cone has an opening angle of $\pm 3^\circ$ (Extended Data Fig. 1), and the projected distance at which the outflow reaches $v_{\text{max}} = 350$ km s$^{-1}$ is $r = 1.8$ kpc. At $r > r$, the deceleration phase starts (see Fig. 3). We have derived the characteristic outflow speed at $v_{\text{out}} = \sqrt{2}v_{\text{max}} / (3f)$. $i$ is the inclination and $\sigma_{\text{kin}} = 505 \pm 120$ km s$^{-1}$ is the average velocity dispersion of the gas inside the [O iii] cone (Fig. 3). This term takes into account the spread of velocities along the line of sight and additional turbulence that may be substantial. Although our geometric model of the [O iii] cone does not constrain $i$, it excludes values smaller than $25^\circ$ (which would imply that the face of the cone that is closer to us is blueshifted) and greater than $65^\circ$ (a nearly face-on view to the cone). We assume that $i$ is $\approx 70^\circ$. We use this inclination for the standard value of $i$ in our APO/DIS and VLT/SINFONI data. For the [O iii] cone, we estimate the mass outflow rates. For the second method, we used equation (2) in ref. 43 with an ambient density of a uniform low-density medium $n_0 = 0.5$ cm$^{-3}$ and a covering factor of $1$ (these values probably represent upper limits for these parameters). We found an energy injection rate of $1.5 \times 10^{44}$ erg s$^{-1}$ and $2 \times 10^{44}$ erg s$^{-1}$ for the $H_2$ bubble and the [O iii] cone, respectively. We adopted a fiducial range between $1.2 \times 10^{44}$ erg s$^{-1}$ and $1.5 \times 10^{44}$ erg s$^{-1}$ for $E_{\text{bubbl e}}$, and between $2 \times 10^{44}$ erg s$^{-1}$ and $2 \times 10^{44}$ erg s$^{-1}$ for $E_{\text{AGN}}$, using single fiducial values (the average of the lower and upper limits) for $E_{\text{bubbl e}}$ and $E_{\text{AGN}}$, respectively. The results of the two approaches indicate that the outflow in the [O iii] cone is about 15 times more powerful than the $H_2$ bubble, which reflects the fact that the former is faster and slightly more extended than the latter.

We can estimate the amount of mechanical energy returned from the nuclear starburst as $E_{\text{mech}} = 7 \times 10^{44}$ for the [O iii] cone. Assuming a SFR of 100 M$\odot$ yr$^{-1}$ in the central region of the galaxy, the total injection of energy from the stars is $7 \times 10^{44}$ erg s$^{-1}$. Thus, star formation is consistent with powering the outflow in the [O iii] cone, which reflects the fact that the former is faster and slightly more extended than the latter. In addition, energy injection from the stars could power the outflow in the [O iii] cone at the lower limit of the energy range. However, we consider this unlikely, because this energy injection is below the fiducial value of kinetic power required to drive the outflow in the [O iii] cone. The bolometric luminosity of the dual AGN estimated from NuSTAR hard-X-ray data is $1.1 \times 10^{44}$ erg s$^{-1}$, which is consistent with the value obtained by fitting the spectral energy distribution (about $2 \times 10^{44}$ erg s$^{-1}$). Our upper limit on the kinetic power of the [O iii] cone is consistent with the bolometric luminosity of the dual AGN. We therefore conclude that the dual AGN is energetically capable of powering the outflow in the [O iii] cone without the help of the starburst and that the mechanical energy injection rate from star formation is not powerful enough to accelerate the gas in this region.

In general, it is difficult to identify the driving mechanism of outflowing bubbles. In the case of the $H_2$ bubble, four pieces of evidence suggest that the outflow is driven by star formation. First, the nuclear starburst is energetically capable of driving the outflow without the need to invoke energy from an AGN. Second, the dynamical time of the outflow (about 7.4 Myr) is consistent with the age of the nuclear starburst in NGC 6240 (about 6–9 Myr). Third, from a morphological point of view, a wind perpendicular to a nuclear disk is consistent with the structures of starburst-driven winds, in contrast to AGN-driven outflows, which have random orientations with respect to the galaxy disk. Finally, AGN-driven outflows usually have higher velocities than starburst-driven outflows. The [O iii] cone exhibits gas clouds with velocity dispersion values of about 1,070 km s$^{-1}$, which is much larger than the maximum dispersion of 450 km s$^{-1}$ (see also ref. 35).

Code availability. The SINFONI data used in this study were reduced with the public pipeline available at https://www.eso.org/sci/software/pipelines/ . LINEFIT and the routines used for reducing and analysing the APO/DIS long-slit data are available from the corresponding author upon request.

Data availability. The data plotted in the figures and that support other findings of this study are available from the corresponding author upon reasonable request. The SINFONI data used in this paper (programme 079.B-0576) can be obtained from the ESO Science Archive Facility (http://archive.eso.org/eso/ eso_archive_main.html). The HST images (GO-12552) are available from MAST (https://archive.stsci.edu/hst/).
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Extended Data Fig. 1 | Contour image of [O iii] emission in NGC 6240. The blue curves show linear contours for the HST/F502N observations. The contours are set at 7.5%, 15%, 30%, 45%, 60%, 75% and 90% of the peak of emission. The extended [O iii] emission is traced by the contour representing 7.5% of the peak of emission. The other contours (15–90% of the peak of emission) are located mostly around the two nuclei. A geometric model of the [O iii] cone is shown in light blue. The model was created using the software Shape®. We constrained the model (size and opening angle) to follow the outer contours (7.5% of the peak of emission) of the wedge-shaped structure in region 1. Interestingly, a regular cone (a cone with a sharp apex) does not provide a good fit to the wedge-shaped structure. The best fit is obtained for a truncated cone. If we had used a regular cone, the apex would be located exactly at the position of the southwestern nucleus. This is consistent with our interpretation that the [O iii] cone is probably produced by the two AGNs, with a larger contribution from the southwestern nucleus. For the [O iii] cone, we obtained a size of 3.7 ± 0.2 kpc and an opening angle of 50.2 ± 3.1°. The red-shaded rectangles indicate the spatial coverage of the long slits of the DIS. PA₁ = 22° is oriented along the major axis of the galaxy disk, and PA₂ = 56° covers the region where the [O iii] cone is observed (region 1). Both slits were centred between the nuclei. The dashed rectangle represents the SINFONI field of view. North is up and east is to the left.
Extended Data Fig. 2 | Comparison of the morphologies of [O iii] and H$_2$. An image of H$_2$ emission obtained with the near-infrared camera 2 (NIRC2) of the Keck adaptive optics system is superimposed on the [O iii] contours from Extended Data Fig. 1. Black represents fluxes < 0.011 of the peak of emission. The absence of molecular gas at the locations of the [O iii] cone and the H$\alpha$ bubble clearly indicates that these two structures are located in regions that are not greatly influenced by the merger process. By contrast, the majority of perturbations caused by the merger activity are seen in the central region between the nuclei, and as gas streamers in the regions east and southwest of the SW nucleus (regions 3 and 4 in our analysis; see also Fig. 2b).
Extended Data Fig. 3 | Optical emission-line diagnostic diagrams. The galaxy was observed at two position angles, PA$_1$ = 22° and PA$_2$ = 56° (see Extended Data Fig. 1). The positive values of angular distance (green to red in the colour bar) correspond to the direction north of the centre of the galaxy, at that position angle. Negative angular distance values (green to blue in the colour bar) correspond to the direction south of the centre of the galaxy, at that position angle. The BPT diagram is usually divided into three regions: AGN (or Seyfert), LINER (or LIER, low-ionization emission-line region; see also ref. 50) and H II (or starburst region). In both panels, we plot the extreme starburst diagnostic line$^{21}$ (curved dashed line) and the LIER/LINER diagnostic line$^{39}$ (straight dashed line). H$β$ emission was detected with a signal-to-noise ratio higher than 3 in 16 spatial elements at PA$_1$ = 22° (from $r = -6''$ to $r = 2''$) and in 26 spatial elements at PA$_2$ = 56° (from $r = -5''$ to $r = 6''$). There are 15 spatial elements inside the [O iii] cone (Fig. 3). The error bars correspond to the uncertainties of the flux ratios (one standard deviation) and were calculated via standard error propagation for the flux of each emission line.
Extended Data Fig. 4 | Map of Brγ velocity dispersion. The contours delineate the Brγ flux distribution and are set at 15%, 30%, 45%, 60%, 75% and 90% of the peak of emission. The dashed rectangle delimits the base of the Hα bubble. Regions in white correspond to pixels where the Brγ flux is less than 5% of the peak of emission and thus were masked out. North is up and east is to the left. The colour bar indicates the range of velocity dispersion values observed in units of kilometres per second.
Extended Data Fig. 5  |  Map of H₂/Brγ flux ratio. The contours delineate the Brγ flux distribution and are set at 15%, 30%, 45%, 60%, 75% and 90% of the peak of emission. The dashed rectangle delimits the base of the Hα bubble. Regions in white correspond to pixels where the Brγ flux is less than 5% of the peak of emission and thus were masked out. North is up and east is to the left. The colour bar indicates the range of ratios observed.