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NGC 2992: Interplay between the multiphase disc, wind, and radio bubbles

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ABSTRACT

We present an analysis of the gas kinematics in NGC 2992 based on VLT/MUSE, ALMA, and VLA data. Our aim is to characterise the disc, the wind, and their interplay in the cold molecular and warm ionised phases. NGC 2992 is a changing-look Seyfert known to host both a nuclear ultrafast outflow (UFO), and an AGN-driven kiloparsec-scale ionised wind. CO(2–1) and Hα arise from a multiphase disc with an inclination of 80 deg and radii of 1.5 and 1.8 kpc, respectively. By modelling the gas kinematics, we find that the velocity dispersion of the cold molecular phase, $\sigma_{\rm gas}$, is consistent with that of star forming galaxies at the same redshift, except in the inner 600 pc region, and in the region between the cone walls and the disc, where $\sigma_{\rm gas}$ is a factor of 3–4 larger than in star forming galaxies for both the cold molecular and the warm ionised phases. This suggests that a disc–wind interaction locally boosts the gas turbulence. We detect a clumpy ionised wind in Hβ, [O III], Hα, and [N II] distributed in two wide-opening-angle ionisation cones reaching scales of 7 kpc (40 arcsec). The [O III] wind expands with a velocity exceeding -1000 km s^{-1} in the inner 600 pc, which is a factor of approximately five greater than the previously reported wind velocity. Based on spatially resolved electron density and ionisation parameter maps, we infer an ionised outflow mass of $M_{\rm of,ion} = (3.2 \pm 0.3) \times 10^7\ M_\odot$, and a total ionised outflow rate of $\dot{M}_{\rm of,ion} = 13.5 \pm 1\ M_\odot\ {\rm yr}^{-1}$. We detected ten clumps of cold molecular gas located above and below the disc in the ionisation cones, reaching maximum projected distances of 1.7 kpc and showing projected bulk velocities of up to 200 km s^{-1}. On these scales, the wind is multiphase, with a fast ionised component and a slower molecular one, and a total mass of $M_{\rm of,ion+mol} = 5.8 \times 10^7\ M_\odot$, of which the molecular component carries the bulk of the mass, namely $M_{\rm of,mol} = 4.3 \times 10^7\ M_\odot$. The dusty molecular outflowing clumps and the turbulent ionised gas are located at the edges of the radio bubbles, suggesting that the bubbles interact with the surrounding medium through shocks, as also supported by the [O I]/Hα ratio. Conversely, both the large opening angle and the dynamical timescale of the ionised wind detected in the ionisation cones on 7 kpc scales indicate that this is not related to the radio bubbles but instead likely associated with a previous AGN episode. Finally, we detect a dust reservoir that is co-spatial with the molecular disc, with a cold dust mass of $M_{\rm dust} = (4.04 \pm 0.03) \times 10^6\ M_\odot$, which is likely responsible for the extended Fe Kα emission seen on 200 pc scales in hard X-rays and interpreted as reflection by cold dust.

Key words. galaxies: active – galaxies: ISM – galaxies: Seyfert – techniques: interferometric – techniques: high angular resolution – ISM: kinematics and dynamics

1. Introduction

Active galactic nuclei (AGN) can power massive outflows, potentially impacting on interstellar medium (ISM) of the galaxy and altering both star formation and nuclear gas accretion. The growth of the super massive black holes (SMBHs) in the galactic centre is then stopped, as are the nuclear activity and winds, until new cold gas accretes onto the nucleus thereby starting a new AGN episode (Fabian 2012; King & Pounds 2015). This is the so-called feeding and feedback cycle of active galaxies (Tumlinson et al. 2017; Gaspari et al. 2020). Understanding the relation between winds and outflows emerging from accreting