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Supersymmetric Janus solutions in ω-deformed $N = 8$ gauged supergravity

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Abstract We give a large class of supersymmetric Janus solutions in ω-deformed (dyonic) $SO(8)$ maximal gauged supergravity with $\omega = \frac{\pi}{8}$. Unlike the purely electric counterpart, the dyonic $SO(8)$ gauged supergravity exhibits a richer structure of AdS_4 vacua with $N = 8, 2, 1, 1$ supersymmetries and $SO(8)$, $U(3)$, G_2 and $SU(3)$ symmetries, respectively. Similarly, domain walls interpolating among these critical points show a very rich structure as well. In this paper, we show that this gauged supergravity also accommodates a number of interesting supersymmetric Janus solutions in the form of AdS_3-sliced domain walls asymptotically interpolating between the aforementioned AdS_4 geometries. These solutions could be holographically interpreted as two-dimensional conformal defects within the superconformal field theories (SCFTs) of ABJM type dual to the AdS_4 vacua. We also give a class of solutions interpolating among the $SO(8)$, G_2 and $U(3)$ AdS_4 vacua in the case of $\omega = 0$ which have not previously appeared in the presently known Janus solutions of electric $SO(8)$ gauged supergravity.

1 Introduction

Janus solutions of D-dimensional gauged supergravity take the form of AdS_{D-1}-sliced domain walls. Regular solutions of this type are asymptotic to AdS_D geometries on both sides of the AdS_{D-1} slice. According to the AdS/CFT correspondence [1–3], these configurations are dual to $(D-2)$-dimensional conformal interfaces or defects in the $(D-1)$-dimensional CFT dual to the AdS_D vacuum. Since the original Janus solution found in [4] by considering a deformation of the $AdS_5 \times S^5$ geometry in type IIB theory, a number of works have studied this type of solutions both in type IIB theory and five-dimensional gauged supergravity along with

the corresponding conformal interfaces in the dual $N = 4$ super Yang–Mills theory, see for example [5–14] for more recent results.

In this paper, we are interested in supersymmetric Janus solutions of dyonic $SO(8)$ gauged supergravity in four dimensions constructed in [15], see also [16]. This gauged supergravity is a deformation of the original $SO(8)$ gauged supergravity constructed long ago in [17] by an electromagnetic phase usually called ω. For $\omega = 0$, a number of Janus solutions have been given in [18], see [19–25] for Janus solutions in four-dimensional gauged supergravities with different numbers of supersymmetries and [26–34] for solutions in other dimensions.

The $SO(8)$ gauged supergravity with $\omega \neq 0$ exhibits a richer structure of supersymmetric AdS_4 vacua [35] compared to the $\omega = 0$ theory. In particular, there exist new $N = 1$ supersymmetric critical points with G_2 and $SU(3)$ symmetries in addition to the $SO(8)$, G_2 and $U(3) \sim SU(3) \times U(1)$ critical points with $N = 8, 1, 2$ supersymmetries which have $\omega = 0$ counterparts. Holographic RG flow solutions interpolating between these critical points have been investigated in [36,37], see also [38], and also show a richer structure than the $\omega = 0$ analogue. We then expect that Janus solutions will exhibit a much richer structure with many possible solutions as well. We will see that this is indeed the case.

Janus solutions given in [18] only involve the $SO(8)$ and G_2 critical points resulting in $SO(8)/SO(8)$, $SO(8)/G_2$ and G_2/G_2 interfaces. The $N = 2$ $U(3)$ critical point is however not present in the two-scalar truncation considered in [18]. Since in this paper, we study solutions in the full $SU(3)$ invariant scalar sector, we also consider Janus solutions with $\omega = 0$ that involve all AdS_4 critical points with $SO(8)$, G_2 and $U(3)$ symmetry. The resulting solutions could hopefully provide the missing part in the list of known Janus solutions in electric $SO(8)$ gauged supergravity. To the best of our

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knowledge, all the solutions with $\omega \neq 0$ have not previously appeared.

The paper is organized as follows. In Sect. 2, we review the construction of four-dimensional $N = 8$ gauged supergravity with dyonic $SO(8)$ gauge group and the corresponding AdS_4 vacua. BPS equations for Janus solutions in $SU(3)$ invariant sector are also given. In Sects. 3 and 4, we give numerical Janus solutions for $\omega = 0$ and $\omega = \frac{\pi}{8}$ cases, respectively. Conclusions and comments on the results are given in Sect. 5.

2 $N = 8$ gauged supergravity with dyonic $SO(8)$ gauge group

We first give a brief review of $N = 8$ gauged supergravity in four dimensions with dyonic $SO(8)$ gauge group constructed in [15,16] to which we refer for more detail. We mostly follow the conventions of [36] with $(-+++)$ signature for the space-time metric. The only supermultiplet in $N = 8$ supersymmetry is given by the supergravity multiplet with the field content

$$(e_\mu^{\hat{\mu}}, \psi_\mu^I, A_\mu^{AB}, \chi_{IJK}, \Sigma_{IJKL}). \tag{1}$$

This multiplet consists of the graviton $e_\mu^{\hat{\mu}}$, 8 gravitini ψ_μ^I, 28 vectors $A_\mu^{AB} = -A_\mu^{BA}$, 56 spin-$\frac{1}{2}$ fields $\chi_{IJK} = \chi_{[IJK]}$ and 70 scalars $\Sigma_{IJKL} = \Sigma_{[IJKL]}$.

Before moving on, we first state the conventions on various indices used throughout the paper. Space-time and tangent space indices are denoted by $\mu, \nu, \ldots = 0, 1, 2, 3$ and $\hat{\mu}, \hat{\nu}, \ldots = 0, 1, 2, 3$, respectively. The $N = 8$ supergravity admits global $E_{7(7)}$ and local composite $SU(8)$ symmetries with the corresponding fundamental representations are respectively described by indices $\mathbb{M}, \mathbb{N}, \ldots = 1, 2, 3, \ldots, 56$ and $I, J, K, \ldots = 1, 2, 3, \ldots 8$. Indices $A, B, \ldots = 1, 2, 3, \ldots, 8$ refer to fundamental indices of $SL(8) \subset E_{7(7)}$. The scalars Σ_{IJKL} are encoded in the $E_{7(7)}/SU(8)$ coset manifold and can be described by the coset representative $\mathcal{V}_\mathbb{M}{}^{\underline{\mathbb{M}}}$. The local $SU(8)$ indices $\underline{\mathbb{M}}, \underline{\mathbb{N}}, \ldots$ will further be decomposed as $\underline{\mathbb{M}} = ([IJ], {}^{[IJ]})$. Similarly, the global $E_{7(7)}$ indices $\mathbb{M}, \mathbb{N}, \ldots$ will be decomposed in the $SL(8)$ basis as $\mathbb{M} = ([AB], {}^{[AB]})$. The scalars Σ_{IJKL} are self-dual

$$\Sigma_{IJKL} = \frac{1}{4!}\epsilon_{IJKLMNPQ}\Sigma^{MNPQ} \tag{2}$$

with $\Sigma^{IJKL} = (\Sigma_{IJKL})^*$ and $\epsilon_{IJKLMNPQ}$ being the invariant tensor of the $SU(8)$ R-symmetry.

The action of the global $E_{7(7)}$ symmetry includes electric-magnetic duality with the vector fields A_μ^{AB} together with the magnetic dual $A_{\mu AB}$ transforming in the fundamental **56** representation. In general, the Lagrangian of the ungauged $N = 8$ supergravity will exhibit only particular subgroups of $E_{7(7)}$ depending on the electric-magnetic or symplectic

frames. On the other hand, the full $E_{7(7)}$ symmetry is realized through the field equations together with the Bianchi identities. The most general gaugings of the $N = 8$ supergravity can be described by the so-called embedding tensor $\Theta_\mathbb{M}{}^\alpha$ which introduces a minimal coupling to various fields in the ungauged supergravity via the covariant derivative

$$D_\mu = \nabla_\mu - g A_\mu^\mathbb{M} \Theta_\mathbb{M}{}^\alpha t_\alpha \tag{3}$$

with ∇_μ being the usual space-time covariant derivative including the $SU(8)$ composite connection (if any). t_α are $E_{7(7)}$ generators with $\alpha = 1, 2, 3, \ldots, 133$. Supersymmetry requires the embedding tensor to transform as **912** representation of $E_{7(7)}$. In addition, the gauge generators $X_\mathbb{M} = \Theta_\mathbb{M}{}^\alpha t_\alpha$ must form a closed subalgebra of $E_{7(7)}$. The latter imposes the quadratic constraint on the embedding tensor of the form

$$\Omega^{\mathbb{MN}}\Theta_\mathbb{M}{}^\alpha\Theta_\mathbb{N}{}^\beta = 0. \tag{4}$$

$\Omega^{\mathbb{MN}}$ is the symplectic form of the duality group $Sp(56, \mathbb{R})$ in which $E_{7(7)}$ is embedded. The quadratic constraint can be rewritten in terms of the gauge generators as

$$[X_\mathbb{M}, X_\mathbb{N}] = -X_{\mathbb{MN}}{}^\mathbb{P} X_\mathbb{P} \tag{5}$$

with $X_{\mathbb{MN}}{}^\mathbb{P} = \Theta_\mathbb{M}{}^\alpha(t_\alpha)_\mathbb{N}{}^\mathbb{P}$ and $(t_\alpha)_\mathbb{N}{}^\mathbb{P}$ being the $E_{7(7)}$ generators in the fundamental representation.

In this paper, we are interested mainly in the solutions with only the metric and scalars non-vanishing. We will from now on set all the other fields to zero to simplify the presentation. The bosonic Lagrangian of the $N = 8$ gauged supergravity can be written as

$$e^{-1}\mathcal{L} = \frac{1}{2}R - \frac{1}{12}P_\mu^{IJKL}P^\mu_{IJKL} - V. \tag{6}$$

The scalar potential is given in terms of the fermion-shift matrices as

$$V = -\frac{3}{4}g^2 A_{1IJ}A_1^{IJ} + \frac{1}{24}g^2 A_{2I}{}^{JKL}A_{2JKL}^I \tag{7}$$

with $A_{2I}{}^{IJ} = (A_{1IJ})^*$ and $A_{2I}{}^{JKL} = (A_{2JKL}^I)^*$. A_1 and A_2 matrices can be defined in term of the T-tensor by the following relations

$$A_1^{IJ} = \frac{4}{21}T^{IKJL}{}_{KL} \quad \text{and} \quad A_{2I}{}^{JKL} = 2T_{MI}{}^{MJKL}. \tag{8}$$

The T-tensor is in turn obtained from the embedding tensor via

$$T_{\underline{\mathbb{MN}}}{}^\mathbb{P} = \mathcal{V}^\mathbb{M}{}_{\underline{\mathbb{M}}}\mathcal{V}^\mathbb{N}{}_{\underline{\mathbb{N}}}\mathcal{V}_\mathbb{P}{}^\mathbb{P} X_{\mathbb{MN}}{}^\mathbb{P} \tag{9}$$

with $\mathcal{V}^\mathbb{M}{}_{\underline{\mathbb{M}}} = (\mathcal{V}^{-1})_{\underline{\mathbb{M}}}{}^\mathbb{M}$.

The supersymmetry transformations of ψ_μ^I and χ_{IJK}, which are needed in finding supersymmetric solutions, are given by

$$\delta\psi_\mu^I = 2D_\mu\epsilon^I + \sqrt{2}g A_1^{IJ}\gamma_\mu\epsilon_J, \tag{10}$$

$$\delta\chi^{IJK} = -2\sqrt{2}P_\mu^{IJKL}\gamma^\mu\epsilon_L - 2g A_{2L}{}^{IJK}\epsilon^L. \tag{11}$$

The covariant derivative of ϵ^I is defined by

$$D_\mu \epsilon^I = \partial_\mu \epsilon^I + \frac{1}{4}\omega_\mu{}^{\hat{\mu}\hat{\nu}}\gamma_{\hat{\mu}\hat{\nu}}\epsilon^I + \frac{1}{2}Q_\mu{}^I{}_J \epsilon^J. \tag{12}$$

The composite connection $Q_\mu{}^I{}_J = (Q_{\mu I}{}^J)^*$ and the vielbein P_μ^{IJKL} on the $E_{7(7)}/SU(8)$ coset are given by

$$Q_{\mu I}{}^J = \frac{i}{3}(\mathcal{V}_{ABIK}\partial_\mu \mathcal{V}^{JK} - \mathcal{V}^{AB}{}_{IK}\partial_\mu \mathcal{V}_{AB}{}^{JK}), \tag{13}$$

$$P_{\mu IJKL} = \frac{i}{2}(\mathcal{V}_{ABIJ}\partial_\mu \mathcal{V}^{AB}{}_{KL} - \mathcal{V}^{AB}{}_{IJ}\partial_\mu \mathcal{V}_{ABKL}) \tag{14}$$

with

$$P_\mu^{IJKL} = \frac{1}{4!}\epsilon^{IJKLMNPQ}P_{\mu MNPQ}. \tag{15}$$

We finally note that the kinetic term and the scalar potential can be written in term of the symmetric scalar matrix

$$\mathcal{M}_{\mathbb{MN}} = \mathcal{V}_{\mathbb{M}}{}^{\underline{\mathbb{M}}}\mathcal{V}_{\mathbb{N}}{}^{\underline{\mathbb{N}}}\eta_{\underline{\mathbb{MN}}} \quad \text{with} \quad \eta_{\underline{\mathbb{MN}}} = \begin{pmatrix} 0 & \mathbb{I}_{28} \\ \mathbb{I}_{28} & 0 \end{pmatrix} \tag{16}$$

as

$$-\frac{1}{12}P_\mu^{IJKL}P_{IJKL}^\mu = \frac{1}{96}\partial_\mu \mathcal{M}_{\mathbb{MN}}\partial^\mu \mathcal{M}^{\mathbb{MN}} \tag{17}$$

and

$$V = \frac{g^2}{672}\left(X_{\mathbb{MN}}{}^{\mathbb{R}}X_{\mathbb{PQ}}{}^{\mathbb{S}}\mathcal{M}^{\mathbb{MP}}\mathcal{M}^{\mathbb{NQ}}\mathcal{M}_{\mathbb{RS}} \right.$$
$$\left. +7X_{\mathbb{MN}}{}^{\mathbb{Q}}X_{\mathbb{PQ}}{}^{\mathbb{N}}\mathcal{M}^{\mathbb{MP}} \right). \tag{18}$$

$\mathcal{M}^{\mathbb{MN}}$ is the inverse of $\mathcal{M}_{\mathbb{MN}}$.

2.1 Dyonic $SO(8)$ gauging

In general, both electric and magnetic vector fields can participate in the gauging. We now consider gauging of a subgroup $G \subset SL(8) \subset E_{7(7)}$. The $SL(8)$ generators take a block-diagonal form, and various components of the embedding tensor corresponding to the gauge group G are given by

$$X_{[AB][CD]}{}^{[EF]} = -8\delta_{[A}^{[E}\theta_{B][C}\delta_{D]}^{F]},$$
$$X_{[AB]}{}^{[CD]}{}_{[EF]} = 8\delta_{[A}^{[C}\theta_{B][E}\delta_{F]}^{D]},$$
$$X^{[AB]}{}_{[CD]}{}^{[EF]} = -8\delta_{[C}^{[A}\xi^{B][E}\delta_{D]}^{F]},$$
$$X^{[AB][CD]}{}_{[EF]} = 8\delta_{[E}^{[A}\xi^{B][C}\delta_{F]}^{D]}. \tag{19}$$

The quadratic constraint gives rise to the condition

$$\theta\xi = \frac{1}{8}\text{Tr}(\theta\xi)\mathbb{I}_8 \tag{20}$$

which implies

$$\xi = c\theta^{-1}. \tag{21}$$

The tensors θ and ξ are symmetric and can be diagonalized to have eigenvalues 0, ± 1. This leads to $CSO(p,q,r)$ gauge

group with $p + q + r = 8$ for p, q and r being numbers of eigenvalues 1, -1 and 0, respectively. It is also convenient to define another parameter ω by the following relation

$$\omega = \text{Arg}(1 + ic) \tag{22}$$

with $c = 0$ ($\omega = 0$) and $c = \infty$ ($\omega = \frac{\pi}{2}$) leading to purely electric and purely magnetic gauge groups, respectively. The former is the original $SO(8)$ gauged supergravity of [17]. It has been shown in [15,35,39,40] that the values of ω are equivalent under the identifications $\omega \to -\omega$ and $\omega \to \omega + \frac{\pi}{4}$. This results in inequivalent values of ω in the range $[0, \frac{\pi}{8}]$. In this paper, we are only interested in the case of $\theta_{AB} = \xi^{AB} = \delta_{AB}$ corresponding to the $SO(8)$ gauge group.

2.2 $SU(3)$ truncation

In order to make things more manageable, most results on $N = 8$ gauged supergravity are obtained by truncating the 70-dimensional $E_{7(7)}/SU(8)$ manifold to lower-dimensional submanifolds invariant under certain subgroups of the gauge group. In this work, we are interested in scalar fields that are singlets of $SU(3) \subset SO(8)$ [35] following the discussion in [36]. The embedding of $SU(3)$ can be identified by decomposing the $\mathbf{8}_v$ representation of $SO(8)$ to $\mathbf{1} + \mathbf{1} + \mathbf{3} + \bar{\mathbf{3}}$ of $SU(3)$. Accordingly, the fundamental $SU(8)$ index I splits as $I = (1, a, \hat{1}, \hat{a})$ for $a = 2, 3, 4$ and $\hat{a} = \hat{2}, \hat{3}, \hat{4}$.

After the truncation, there are six scalars parametrizing the coset space

$$SL(2)/SO(2) \times SU(2,1)/U(2) \tag{23}$$

and two gauge fields corresponding to $U(1) \times U(1)$ gauge group. The unbroken supersymmetry in the truncated theory is given by ϵ^1 and $\epsilon^{\hat{1}}$ which are singlets of $SU(3)$. The resulting theory is $N = 2$ gauged supergravity coupled to one vector multiplet and one hypermultiplet.

Under $SO(8)$ gauge group, the 70 scalars Σ_{IJKL} decompose into self- and anti-self-dual parts $\Sigma^\pm_{IJKL}$ in representations $\mathbf{35}_s$ and $\mathbf{35}_c$, respectively. The $\mathbf{35}_s$ and $\mathbf{35}_c$ can be rewritten in terms of real and imaginary parts of 35 complex scalars which are identified respectively with scalars and pseudoscalars. For the $\omega = 0$ case with known eleven-dimensional origin, the former arise from the eleven-dimensional metric while the latter come from the three-form potential. They are respectively dual to boson and fermion bilinear operators in the dual $N = 8$ SCFT.

Two of the six singlets in (23) can be gauged away by the $U(1) \times U(1)$ gauge symmetry [41]. The remaining four scalars can be described by the four-form Σ_{IJKL} of the form

$$\Sigma = \xi \cos\phi(\Sigma_+ + \Sigma_+^*) + i\xi \sin\phi(\Sigma_- - \Sigma_-^*)$$
$$- \zeta \cos\chi J^+ \wedge J^+ - i\zeta \sin\chi J^- \wedge J^- \tag{24}$$

in which the real and complex two-forms $J^{\pm}$ and $\Sigma_{\pm}$ are defined by

$$J^{\pm} = \pm \frac{i}{2} dz_1 \wedge d\bar{z}_{\bar{1}} + \frac{i}{2} \sum_{a=2}^{4} dz_a \wedge d\bar{z}_{\bar{a}} \qquad (25)$$

and

$$\Sigma_+ = dz_1 \wedge dz_a \wedge dz_b \wedge dz_c,$$
$$\Sigma_- = d\bar{z}_{\bar{1}} \wedge dz_a \wedge dz_b \wedge dz_c. \qquad (26)$$

The complex coordinates $z_i = (z_1, z_a)$ and their complex conjugate $\bar{z}_{\bar{i}} = (\bar{z}_{\bar{1}}, \bar{z}_{\bar{a}})$ are given in terms of a real vector $(x_1, \ldots, x_4, x_{\hat{1}}, \ldots, x_{\hat{4}})$ of $\mathbf{8}_v$ as

$$z_i = x_i + i x_{\hat{i}} \qquad \text{and} \qquad \bar{z}_{\bar{i}} = x_i - i x_{\hat{i}} \qquad (27)$$

Components of Σ_{IJKL} given in (24) can be used to construct the scalar coset representative $\mathcal{V}_{\mathbb{M}}{}^{\underline{\mathbb{M}}}$.

In this $SU(3)$ truncation, the scalar kinetic term can be written as

$$\mathcal{L}_{\text{kin}} = -3\partial_\mu \zeta \partial^\mu \zeta - \frac{3}{4} \sinh^2(2\zeta) \partial_\mu \chi \partial^\mu \chi$$
$$-4\partial_\mu \xi \partial^\mu \xi - \sinh^2(2\xi) \partial_\mu \phi \partial^\mu \phi. \qquad (28)$$

The resulting components of the A_1^{IJ} tensor split into $(A_1^{11}, A_1^{aa}, A_1^{\hat{1}\hat{1}}, A_1^{\hat{a}\hat{a}})$ and take the form of

$$A_1^{IJ} = e^{i\omega} A_+^{IJ} + e^{-i\omega} A_-^{IJ}. \qquad (29)$$

A_1^{11} and $A_1^{\hat{1}\hat{1}}$ correspond to the unbroken $N = 2$ supersymmetry giving rise to the superpotentials $\mathcal{W}_1$ and $\mathcal{W}_{\hat{1}}$. The scalar potential can be written in term of the real superpotential $W = |\mathcal{W}_1| = |\mathcal{W}_{\hat{1}}|$ as

$$V = \frac{1}{3} \frac{\partial W}{\partial \zeta} \frac{\partial W}{\partial \zeta} + \frac{4}{3 \sinh^2(2\zeta)} \frac{\partial W}{\partial \chi} \frac{\partial W}{\partial \chi}$$
$$+ \frac{1}{4} \frac{\partial W}{\partial \xi} \frac{\partial W}{\partial \xi} + \frac{1}{\sinh^2(2\xi)} \frac{\partial W}{\partial \phi} \frac{\partial W}{\partial \phi} - 3W^2. \qquad (30)$$

In our convention, the superpotentials $\mathcal{W}_{1,\hat{1}}$ are related to A_1^{11} and $A_1^{\hat{1}\hat{1}}$ by

$$\mathcal{W}_1 = \sqrt{2} g A_1^{11} \qquad \text{and} \qquad \mathcal{W}_{\hat{1}} = \sqrt{2} g A_1^{\hat{1}\hat{1}}. \qquad (31)$$

It should be noted that this definition is different from that used in [36] in which $\mathcal{W}_{1,\hat{1}}$ are directly defined by A_1^{11} and $A_1^{\hat{1}\hat{1}}$. This results in different numerical factors for some expressions, but the final result is the same.

The explicit form of A_1^{11} and $A_1^{\hat{1}\hat{1}}$ is obtained from $A_{\pm}^{11}$ and $A_{\pm}^{\hat{1}\hat{1}}$ given by

$$A_+^{11} = \frac{3}{2} e^{2i(\chi+\phi)} \cosh \zeta \sinh^2 \zeta \sinh^2(2\xi)$$
$$+ \cosh^3 \zeta (\cosh^4 \xi + e^{4i\phi} \sinh^4 \xi), \qquad (32)$$

$$A_-^{11} = \frac{3}{2} e^{2i(\chi+\phi)} \cosh \zeta \sinh^2 \zeta \sinh^2(2\xi)$$
$$+ e^{3i\chi} \sinh^3 \zeta (\cosh^4 \xi + e^{4i\phi} \sinh^4 \xi) \qquad (33)$$

Table 1 Supersymmetic AdS_4 vacua of $SO(8)$ gauged supergravity with $\omega = \frac{\pi}{8}$. The first three critical points have $\omega = 0$ counterparts while the last two are genuine critical points of the dyonic $SO(8)$ gauged supergravity without the $\omega = 0$ analogues. For $N = 1$ critical points, we also note which superpotential among W_1 and $W_{\hat{1}}$ corresponds to the unbroken supersymmetry

Supersymmetry	Residual symmetry	(ζ, χ, ξ, ϕ)
$N = 8$	$SO(8)$	$(0, 0, 0, 0)$
$N = 2$	$U(3) \sim SU(3) \times U(1)$	$(0.315, 0.171\pi, 0.375, \pm\frac{\pi}{2})$
		$(0.315, 1.329\pi, 0.375, 0)$
		$(0.315, 1.329\pi, 0.375, \pi)$
$N = 1$ W_1	G_2	$(0.329, 0.373\pi, 0.329, \pm 0.373\pi)$
		$(0.329, 0.373\pi, 0.329, \pm 1.373\pi)$
$W_{\hat{1}}$		$(0.329, 1.127\pi, 0.329, \pm 1.127\pi)$
		$(0.329, 1.127\pi, 0.329, \pm 0.127\pi)$
$N = 1$ W_1	G_2	$(0.242, -\frac{\pi}{4}, 0.242, \mp\frac{\pi}{4})$
$W_{\hat{1}}$		$(0.242, -\frac{\pi}{4}, 0.242, \pm\frac{3\pi}{4})$
$N = 1$ W_1	$SU(3)$	$(0.275, \frac{3\pi}{4}, 0.573, \pm\frac{\pi}{4})$
$W_{\hat{1}}$		$(0.275, \frac{3\pi}{4}, 0.573, \mp\frac{3\pi}{4})$

with

$$A_{\pm}^{\hat{1}\hat{1}} = A_{\pm}^{11}(\phi \to -\phi). \qquad (34)$$

Since the explicit form of the scalar potential is rather complicated, we refrain from giving it here but simply refer to [36].

A number of supersymmetric AdS_4 vacua of the scalar potential have been identified, and some of them do not have counterparts in the $\omega = 0$ case. Before considering supersymmetric Janus solutions, for convenience, we collect all of the known supersymmetric AdS_4 critical points for $\omega = \frac{\pi}{8}$ in Table 1.

2.3 BPS equations for Janus solutions

We are now in a position to analyze the fermionic supersymmetry transformations and find the corresponding BPS equations. The analysis closely follows that given in [18], see also [19], to which the reader is referred for more detail.

We begin with the metric ansatz of the form

$$ds^2 = e^{2A(r)} \left(e^{\frac{2\rho}{\ell}} dx_{1,1}^2 + d\rho^2 \right) + dr^2. \qquad (35)$$

This is the domain wall metric with an AdS_3 slice rather than the three-dimensional flat Minkowski space. The latter is recovered in the limit $\ell \to \infty$.

With the vielbein components

$$e^{\hat{\alpha}} = e^{A + \frac{\rho}{\ell}} dx^\alpha, \qquad e^{\hat{\rho}} = e^A d\rho, \qquad e^{\hat{r}} = dr, \qquad (36)$$

non-vanishing components of the spin connection from the above metric are given by

$$\omega^{\hat{\rho}}\hat{r} = A'e^{\hat{\rho}}, \qquad \omega^{\hat{\alpha}}\hat{\rho} = \frac{1}{\ell}e^{-A}e^{\hat{\alpha}}, \qquad \omega^{\hat{\alpha}}\hat{r} = A'e^{\hat{\alpha}} \qquad (37)$$

where $'$ denotes the r-derivative. Indices α, β will take values 0, 1. The other non-vanishing fields are the scalars (ζ, ξ, χ, ϕ) depending only on r.

We will use Majorana representation for gamma matrices with all γ^μ real and γ_5 purely imaginary. The two chiralities of the supersymmetry parameters ϵ^I and ϵ_I are then related to each other by a complex conjugation. We will denote the Killing spinors corresponding to the unbroken supersymmetry by ϵ. In the present case, ϵ will be ϵ^1 or $\epsilon^{\hat{1}}$, and ϵ^* is given by ϵ_1 or $\epsilon_{\hat{1}}$. The supersymmetry conditions $\delta\chi^{IJK} = 0$ involve only $\gamma_{\hat{r}}$ since the scalars depend only on r. Following [18], we impose the projector of the form

$$\gamma_{\hat{r}}\epsilon = e^{i\Lambda}\epsilon^* \qquad (38)$$

where Λ is real.

We now consider the supersymmetry transformations $\delta\psi^I_{\hat{\alpha}}$ which lead to the following conditions

$$A'\gamma_{\hat{r}}\epsilon + \frac{1}{\ell}e^{-A}\gamma_{\hat{\rho}}\epsilon + \mathcal{W}\epsilon^* = 0. \qquad (39)$$

The superpotential $\mathcal{W}$ is given by $\sqrt{2}gA_1^{11}$ or $\sqrt{2}gA_1^{\hat{1}\hat{1}}$. Taking the complex conjugate and iterating the above equation, we obtain

$$A'^2 = W^2 - \frac{1}{\ell^2}e^{-2A} \qquad (40)$$

for $W = |\mathcal{W}|$.

We now move to the equation coming from $\delta\psi^I_{\hat{\rho}} = 0$. This takes the form

$$e^{-A}\partial_\rho\epsilon + \frac{1}{2}A'\gamma_{\hat{\rho}}\gamma_{\hat{r}}\epsilon + \frac{1}{2}\mathcal{W}\gamma_{\hat{\rho}}\epsilon^* = 0. \qquad (41)$$

Using (39), we find

$$\partial_\rho\epsilon = \frac{1}{2\ell}\epsilon \qquad (42)$$

which gives $\epsilon = e^{\frac{\rho}{2\ell}}\tilde{\epsilon}$ for a ρ-independent $\tilde{\epsilon}$.

Finally, using the $\gamma_{\hat{\rho}}$ projection of the form

$$\gamma_{\hat{\rho}}\epsilon = i\kappa e^{i\Lambda}\epsilon^* \qquad (43)$$

with $\kappa^2 = 1$ and $\delta\psi^I_{\hat{r}} = 0$, we can determine the explicit form of the Killing spinor to be

$$\epsilon = e^{\frac{A}{2} + \frac{\rho}{2\ell} + i\frac{\Lambda}{2}}\varepsilon^{(0)} \qquad (44)$$

The spinor $\varepsilon^{(0)}$ might have an r-dependent phase and satisfies

$$\gamma_{\hat{r}}\varepsilon^{(0)} = \varepsilon^{(0)*} \quad \text{and} \quad \gamma_{\hat{\rho}}\varepsilon^{(0)} = i\kappa\varepsilon^{(0)*}. \qquad (45)$$

Using the projector (43) in Eq. (39), we find

$$e^{i\Lambda} = \frac{\mathcal{W}}{A' + \frac{i\kappa}{\ell}e^{-A}}. \qquad (46)$$

We can then use the projector (38) with this phase in the $\delta\chi^{IJK} = 0$ conditions and find the BPS equations for the scalar fields. The resulting BPS equations can be written in terms of the superpotential as

$$\zeta' = -\frac{1}{3}\frac{A'}{W}\frac{\partial W}{\partial\zeta} - \frac{1}{3}\frac{2}{\sinh(2\zeta)}\frac{\kappa e^{-A}}{W\ell}\frac{\partial W}{\partial\chi}, \qquad (47)$$

$$\chi' = -\frac{1}{3}\frac{A'}{W}\frac{4}{\sinh^2(2\zeta)}\frac{\partial W}{\partial\chi} + \frac{1}{3}\frac{2}{\sinh(2\zeta)}\frac{\kappa e^{-A}}{W\ell}\frac{\partial W}{\partial\zeta}, \qquad (48)$$

$$\xi' = -\frac{1}{4}\frac{A'}{W}\frac{\partial W}{\partial\xi} - \frac{1}{4}\frac{2}{\sinh(2\xi)}\frac{\kappa e^{-A}}{W\ell}\frac{\partial W}{\partial\phi}, \qquad (49)$$

$$\phi' = -\frac{A'}{W}\frac{1}{\sinh^2(2\xi)}\frac{\partial W}{\partial\phi} + \frac{1}{4}\frac{2}{\sinh(2\xi)}\frac{\kappa e^{-A}}{W\ell}\frac{\partial W}{\partial\xi}. \qquad (50)$$

As expected, these equations reduce to those of the RG flows studied in [36] in the limit $\ell \to \infty$. It can also be shown that these equations satisfy the corresponding field equations. The complete solutions can be obtained by solving these equations together with (40).

Before giving Janus solutions, we note that the constant $\kappa = \pm 1$ corresponds to the chiralities of the Killing spinor on the two-dimensional defects dual to the AdS_3 slices. This can be seen by using $\gamma_5\epsilon = \epsilon$ which implies

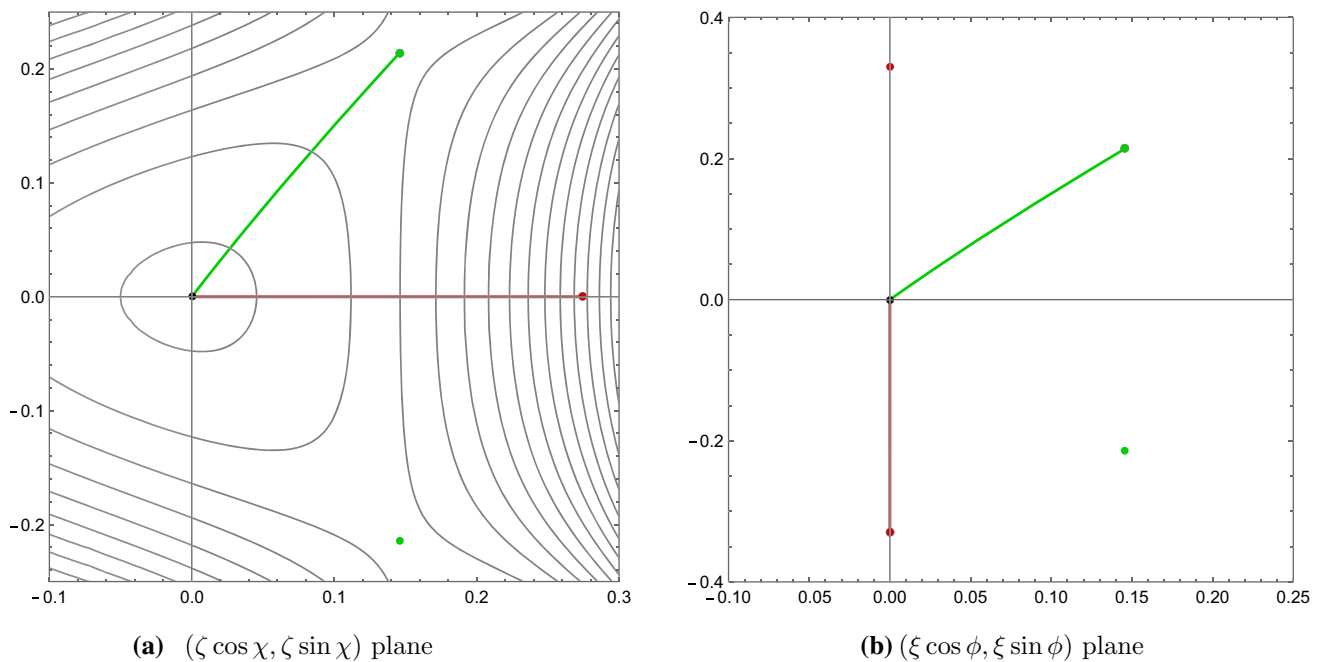$$\gamma^0\gamma^1\epsilon = \kappa\epsilon. \qquad (51)$$

In the present case, we will have Janus solutions with only $N = 1$ supersymmetry, or $(1, 0)$ or $(0, 1)$ superconformal symmetry on the defects, since the above BPS equations can be derived from either $\mathcal{W}_1$ or $\mathcal{W}_{\hat{1}}$. However, at the $SO(8)$ and $U(3)$ critical points, supersymmetry will enhance to $N = 8$ and $N = 2$ respectively.

3 Supersymmetric Janus solutions with $\omega = 0$

In this section, we first consider supersymmetric Janus solutions in the $SO(8)$ gauged supergravity with $\omega = 0$. A number of solutions in the truncation with only two scalars non-vanishing have already been given in [18]. However, the solutions involving the $N = 2$ supersymmetric AdS_4 critical point with $SU(3) \times U(1)$ symmetry have not been studied since this vacuum does not arise in that truncation. In this work, we consider the full $SU(3)$ invariant scalar sector, so it is possible to accommodate this type of solutions. Accordingly, we first give solutions with $\omega = 0$ for which only $SO(8)$, G_2 and $SU(3) \times U(1)$ AdS_4 critical points with $N = 8, 1, 2$ supersymmetries exist.

The resulting BPS equations are highly complicated to look for any analytic solutions. Therefore, we will perform

(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane

(b) $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 1 $SO(8)/SO(8)$ Janus solutions that flow to G_2 and $U(3)$ critical points are given respectively by green and red lines on the contour plot of the superpotential. The two green and red dots represent equivalent G_2 and $U(3)$ critical points

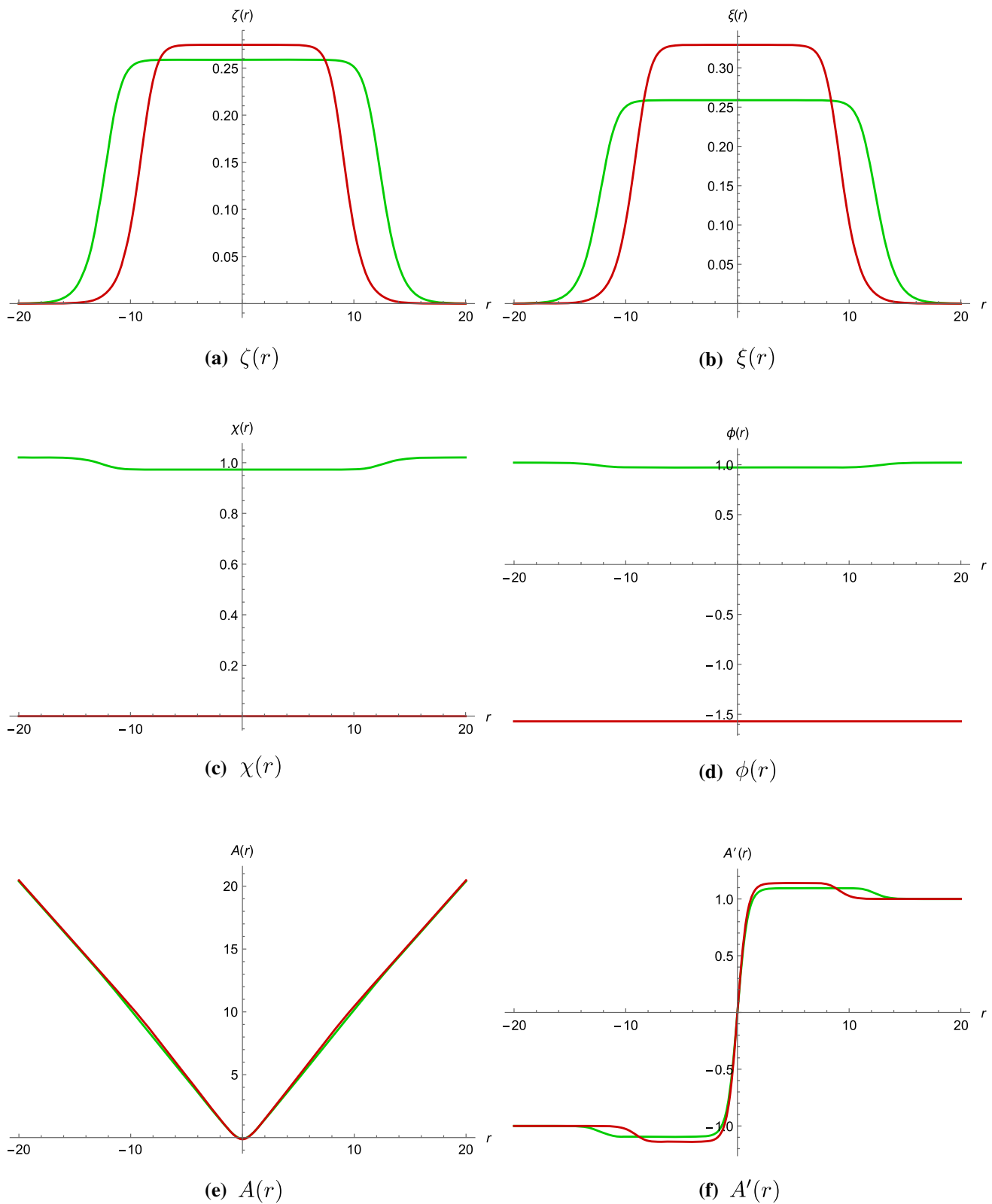a numerical analysis in finding supersymmetric Janus solutions. In subsequent analysis, we will choose the following numerical values

$$g = \frac{1}{\sqrt{2}}, \qquad \ell = 1, \qquad \kappa = 1. \tag{52}$$

The $A'(r)$ equation involves taking a square root giving rise to a branch cut. To avoid this and work with a smooth numerical analysis, we follow the procedure carried out in [18] and instead solve the second order field equations. This process begins with fixing a turning point of A such that $A'(r_0) = 0$ for particular values of ζ_0, ξ_0, χ_0 and ϕ_0. We will conveniently choose $r_0 = 0$ as in [18]. We then determine the values of $A(0)$, $\zeta'(0)$, $\xi'(0)$, $\chi'(0)$ and $\phi'(0)$ using the previously obtained BPS equations. This provides a full set of initial conditions to solve the second order field equations. After numerically integrating to find the solution, we check whether the resulting solution satisfies the BPS equations. For convenience, we will denote a solution interpolating between AdS_4 critical points with G and G' symmetries on the two sides of the interface by G/G' Janus.
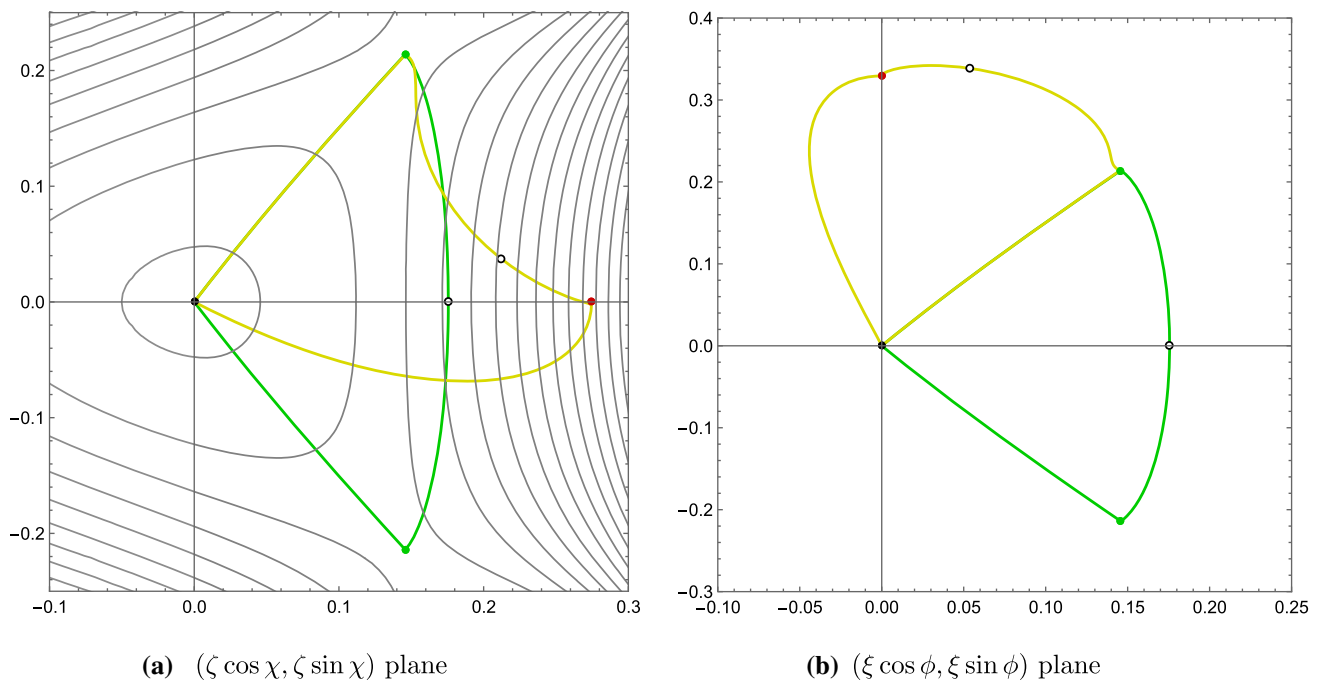
As in [18], there are solutions describing conformal interfaces between $SO(8)$ symmetric phases. These solutions have been studied extensively in [18], so will not repeat them here but mainly focus on solutions involving G_2 and $U(3)$ critical points. We first remark that there exist $SO(8)/SO(8)$ Janus solutions that flow to G_2 and $U(3)$ critical points. These solutions are shown in the contour plot of the superpotential in Fig. 1. In all the contour plots, as in [37], we denote $SO(8)$,

G_2 and $U(3)$ critical points respectively by black, green and red dots while open dots represent turning points. Profiles of scalars and the warped factor A as functions of the radial coordinate r are shown in Fig. 2. We also give the profile of A' in order to make the AdS_4 critical points involving in the solution more transparent. These solutions have a very similar structure to the solutions given in [22]. The only difference is that our solutions asymptotically interpolate between $SO(8)$ conformal phases while those in [22] describe solutions between non-conformal or super Yang-Mills phases. We also note that for this type of solutions the turning points are very close to the critical point to which the solutions flow.

There exist solutions interpolating among the three critical points. Examples of these are shown in Figs. 3 and 4. The yellow line represents a solution from the $SO(8)$ critical point that first proceeds to the G_2 and the $U(3)$ critical points and eventually back to the $SO(8)$ critical point. For comparison, we also show a solution from the $SO(8)$ critical point to the two equivalent G_2 critical points and back to the $SO(8)$ critical point by the green line. The latter has already been given in [18] in which it has been argued that the solution describes a G_2/G_2 interface. In this case, the G_2 phase on each side of the interface is generated from the $SO(8)$ phase by a rapid transition via usual RG flows. Similarly, we interpret our new solution represented by the yellow line as an interface between the G_2 and $U(3)$ conformal phases since on the two sides, the $SO(8)$ phase undergoes an RG flow to the G_2 phase on one side and to the $U(3)$ phase on the other.

(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 2 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A as functions of the radial coordinate r for $SO(8)/SO(8)$ Janus solutions that flow to G_2 and $U(3)$ critical points are shown by green and red lines, respectively

(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane   **(b)** $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 3 Janus solutions describing $G_2/U(3)$ and G_2/G_2 interfaces are respectively shown by yellow and green lines on the contour plot of the superpotential

We also point out that within a larger truncation considered here, there exists a family of G_2/G_2 solutions. Examples of these solutions are shown in Figs. 5 and 6.

We also note here that the two G_2 critical points have the same mass spectra and cosmological constants. Therefore, they are equivalent within the $SO(8)$ gauged supergravity. However, upon uplifted to eleven dimensions, the two critical points give inequivalent eleven-dimensional geometries with opposite magnetic charges for the three-form potential due to the opposite signs of the pseudoscalars. Since in this paper, we will not consider the eleven-dimensional uplift, we simply consider the two critical points equivalent.

For other solutions involving the $U(3)$ critical point, there exists a G_2/G_2 solution that flows to $U(3)$ critical point as shown by the orange line in Figs. 7 and 8. The red line in these figures represents an $SO(8)/U(3)$ interface in which the $SO(8)$ phase undergoes an RG flow to the $U(3)$ phase on one side. The yellow line in Figs. 7 and 8 can also be considered as an interface between $SO(8)$ and G_2 conformal phases. Unlike the $SO(8)/G_2$ solution found in [18], this $SO(8)/G_2$ solution flows to the $U(3)$ critical point near the interface.
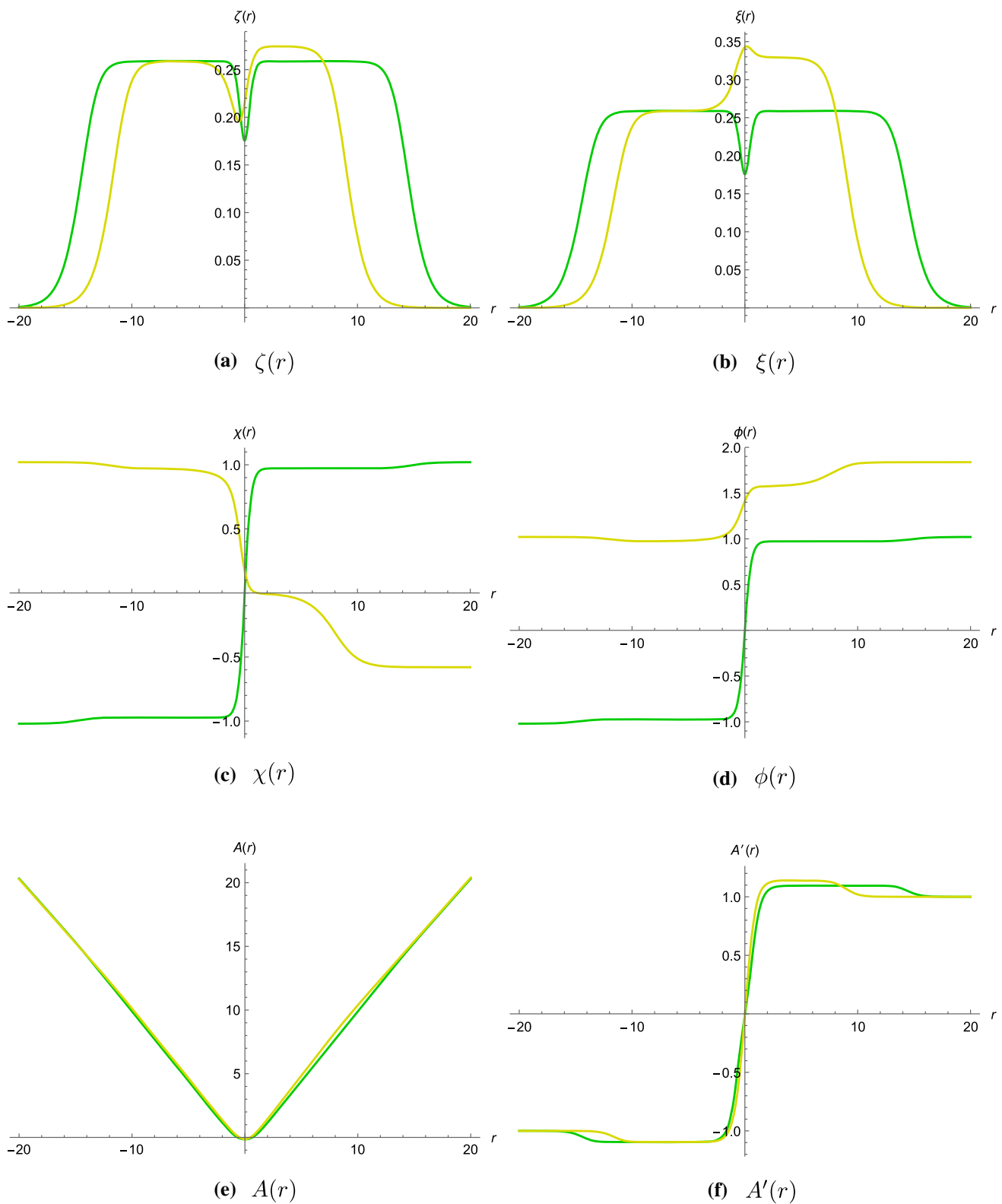
4 Supersymmetric Janus solutions with $\omega \neq 0$

We now look at Janus solutions in the dyonic $SO(8)$ gauged supergravity with $\omega = \frac{\pi}{8}$. In this case, there are two addi-
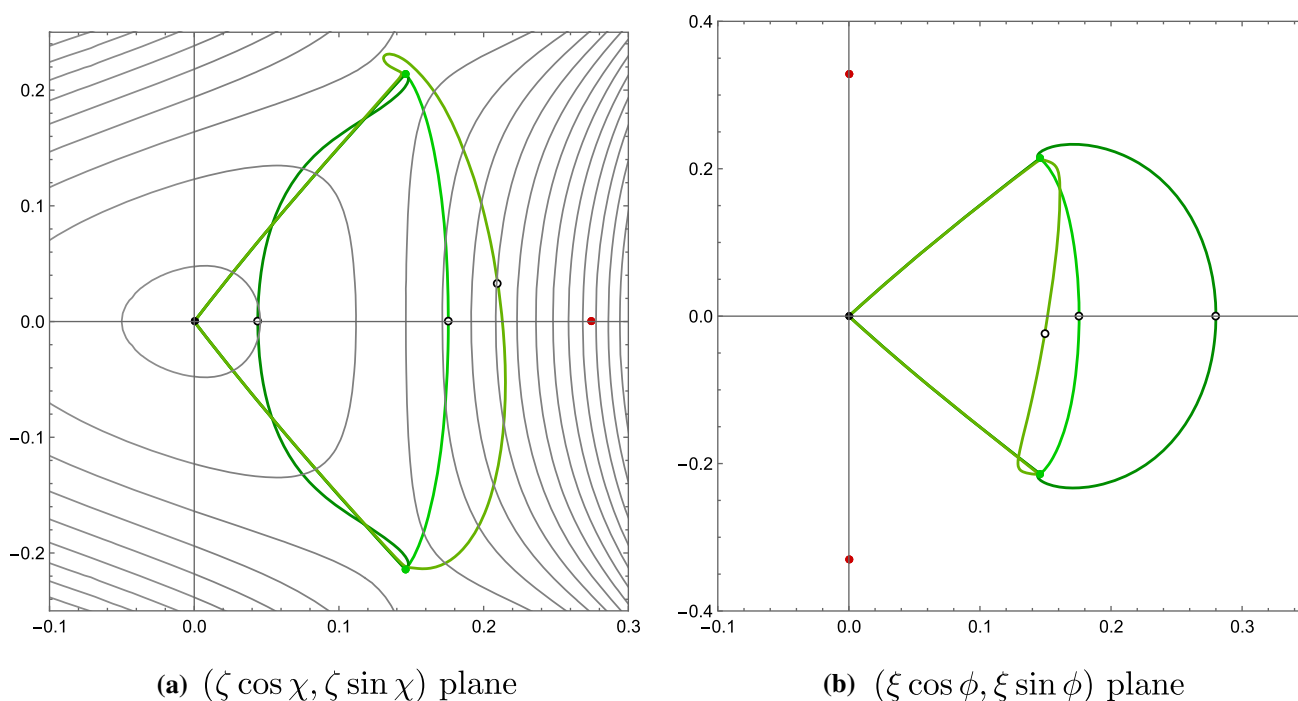
tional $N = 1$ supersymmetric AdS_4 critical points with G_2 and $SU(3)$ symmetries. The former will be denoted by $\overline{G}_2$ to avoid confusion with the previous G_2 critical points in the $\omega = 0$ case. All the AdS_4 critical points of the $\omega = 0$ case are also critical points of the $\omega \neq 0$ case with the positions in field space displaced from the corresponding values with $\omega = 0$ except for the $N = 8$ $SO(8)$ critical point that is still located at $\mathcal{V} = \mathbb{I}$. With more AdS_4 critical points, there are more possibilities for Janus solutions describing various interfaces with different conformal phases on the two sides. In the contour plot of the superpotential, the critical points with $\omega = 0$ analogues will be denoted by the same color code while the $\overline{G}_2$ and $SU(3)$ points will be represented by dark green and blue dots, respectively.

As in the $\omega = 0$ case, there is a family of $SO(8)/SO(8)$ Janus solutions describing interfaces between $SO(8)$ symmetric conformal phases. In addition, there are $SO(8)/SO(8)$ solutions that proceed arbitrarily close to the G_2 and $\overline{G}_2$ points. Some examples of these solutions are shown in Figs. 9 and 11. The $SO(8)/SO(8)$ solution is shown as purple line which is very similar to the solutions in [18] with $\omega = 0$. Similar to the G_2/G_2 Janus solutions in the $\omega = 0$ case, the solution represented by the green line undergoes a rapid transition between the $SO(8)$ and G_2 points and between the $SO(8)$ and $\overline{G}_2$ points on the two sides of the interface. We then argue that this solution describes a $G_2/\overline{G}_2$ interface with the G_2 and $\overline{G}_2$ conformal phases generated by the $SO(8)$ phase on the two sides.

(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 4 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A for G_2/G_2 and $G_2/U(3)$ Janus solutions as functions of the radial coordinate r are shown by green and yellow lines, respectively

(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane

(b) $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 5 Examples of a family of G_2/G_2 Janus solutions on the contour plot of the superpotential

There also exist solutions describing $SO(8)/U(3)$, $SO(8)/G_2$, $SO(8)/\overline{G}_2$ and $SO(8)/SU(3)$ interfaces as shown in Figs. 10 and 12. On one side of these interfaces, the $SO(8)$ phase undergoes an RG flow to the $U(3)$, G_2, $\overline{G}_2$ and $SU(3)$ phases. We should note here that there is an $SO(8)/G_2$ solution that flows to the $SU(3)$ critical point but we have not included this solution for readability of the figures. We also note that in $SO(8)/\overline{G}_2$ (dark green) and $SO(8)/SU(3)$ (blue) solutions, the $SO(8)$ phase is on the right while in the remaining two solutions, the $SO(8)$ phase is on the left (Figs. 11, 12). As in the $\omega = 0$ case, there are also $SO(8)/SO(8)$ solutions that flow to $U(3)$, G_2, $\overline{G}_2$ and $SU(3)$ critical points as shown in Figs. 13 and 15.

We end the discussion on various types of possible solutions by considering a number of solutions shown in Figs. 14 and 16. We first look at the blue line which describes a G_2/G_2 interface that flows to the $SU(3)$ critical point. As in the $\omega = 0$ case, the initial $SO(8)$ phases on both sides undergo a rapid transition to G_2 phases. The red line corresponds to a $U(3)/U(3)$ interface with the $U(3)$ phases generated by the $SO(8)$ phases on each side (Figs. 15, 16). Finally, the solutions represented by yellow and orange lines describe respectively G_2/G_2 and $\overline{G}_2/\overline{G}_2$ interfaces that flow to the $U(3)$ critical point.
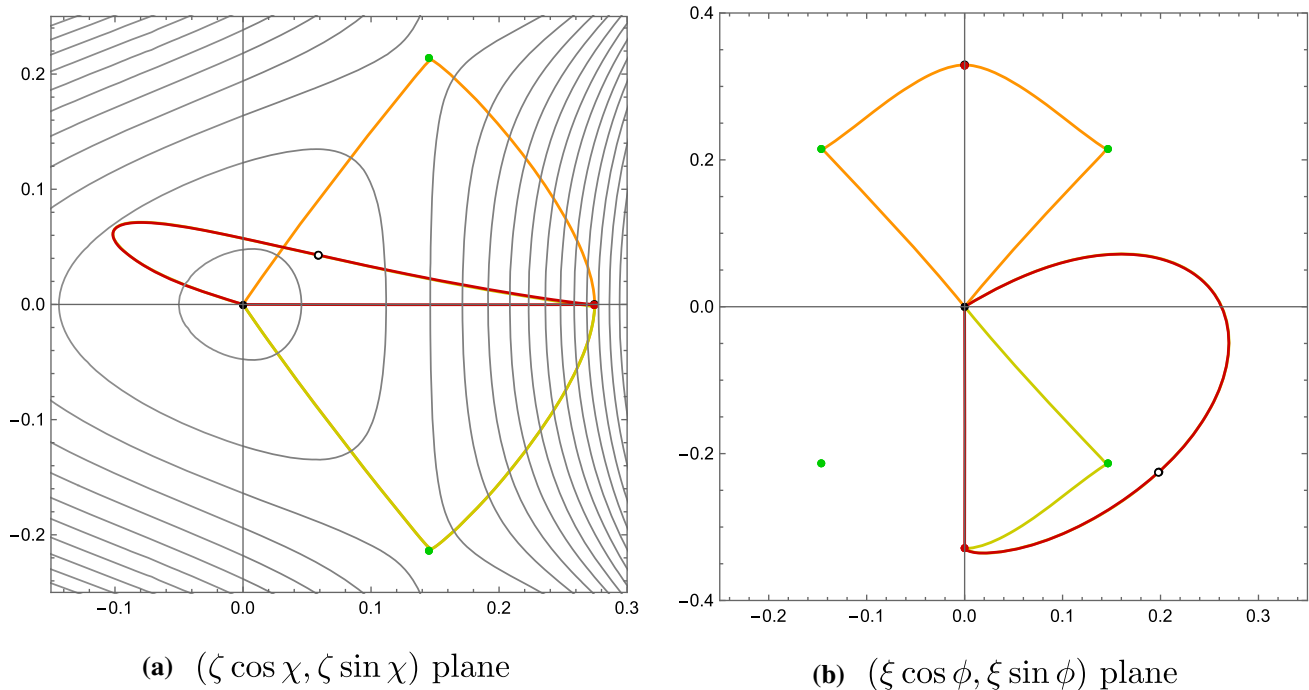
5 Conclusions and discussions

In this paper, we have studied supersymmetric Janus solutions of four-dimensional $N = 8$ gauged supergravity with dyonic $SO(8)$ gauge group in $SU(3)$ invariant sector. For $\omega = 0$, we have found Janus solutions involving the $N = 2$ $U(3)$ critical point and $SO(8)/SO(8)$ solutions that flow to G_2 and $U(3)$ critical points similar to solutions between super Yang–Mills phases given in [22]. In addition to the G_2/G_2 Janus found in [18], we have found an $SO(8)/U(3)$ Janus together with $SO(8)/G_2$ and G_2/G_2 solutions that flow to the $U(3)$ critical point. All these solutions can be uplifted to eleven dimensions by the S^7 truncation and describe conformal interfaces between $SO(8)$, $U(3)$ and G_2 conformal phases of the ABJM theory. These solutions extend the known solutions of [18] in which only $SO(8)/G_2$ and G_2/G_2 Janus solutions have been given. We have also found a family of G_2/G_2 Janus solutions in addition to the solution given in [18].

For $\omega = \frac{\pi}{8}$, there exist two additional supersymmetric $N = 1$ AdS_4 critical points with G_2 and $SU(3)$ symmetries. We have found a number of Janus solutions describing conformal interfaces with various possible conformal phases on each side including solutions that flow to a critical point.

(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 6 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A for examples of G_2/G_2 Janus solutions as functions of the radial coordinate r

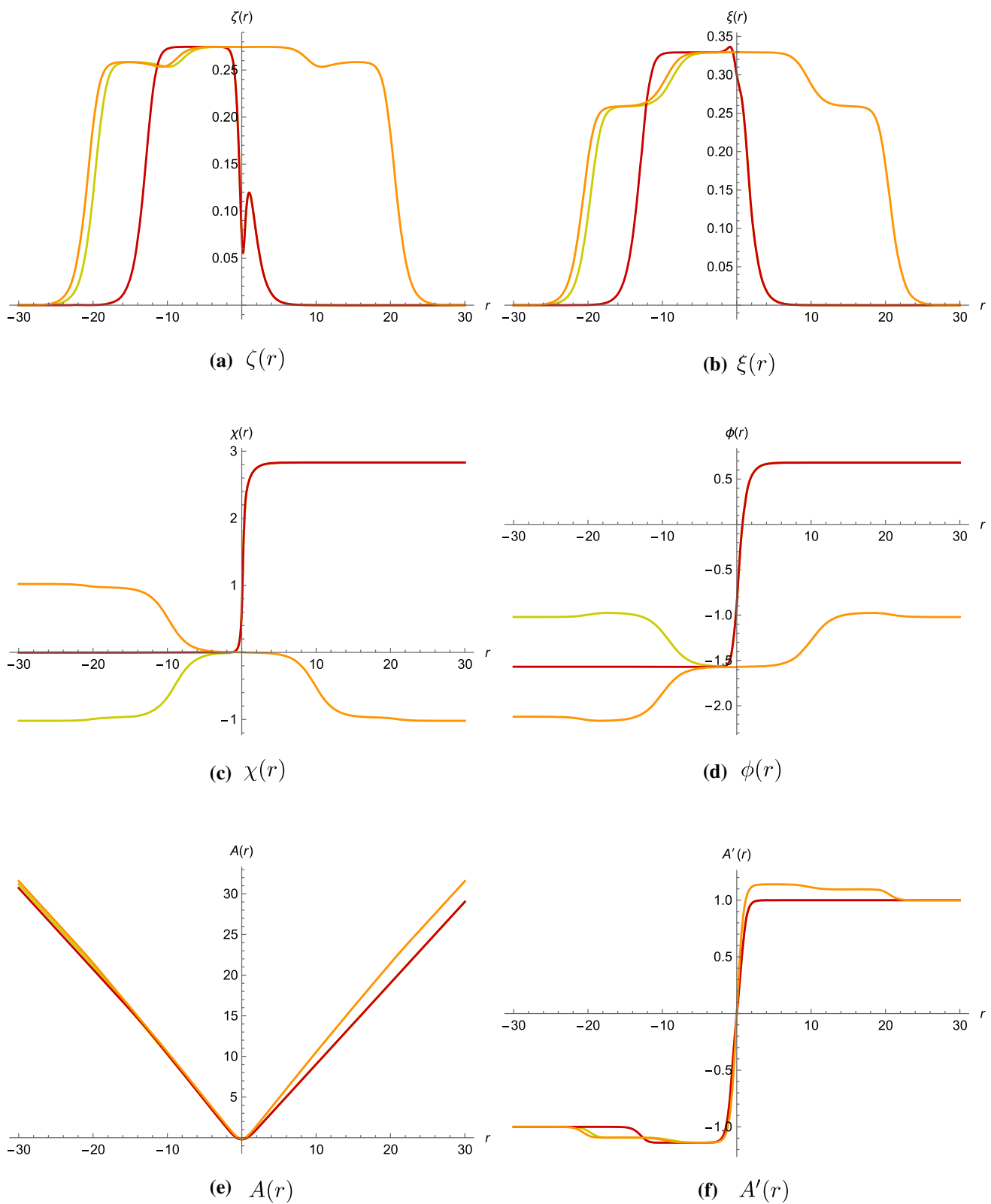(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane

(b) $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 7 An $SO(8)/U(3)$ Janus solution is shown on the contour plot of the superpotential by the red line. The yellow and orange lines represent $SO(8)/G_2$ and G_2/G_2 solutions that flow to the $U(3)$ critical point

With more different phases on each side of the interfaces and more critical points to which the solutions can flow, supersymmetric Janus solutions of dyonic $SO(8)$ gauged supergravity show a highly rich structure as expected from the analogous structure of AdS_4 vacua and domain walls interpolating between them. Unlike the $\omega = 0$ case, the higher dimensional origin of the $SO(8)$ gauged supergravity with $\omega \neq 0$ is presently unknown. Therefore, the uplifted solutions in string/M-theory are currently not possible. The full holographic interpretation of the resulting solutions is still unclear as in the case of RG flows studied in [36,37]. However, by the AdS/CFT correspondence, we expect these solutions to describe conformal interfaces between different conformal phases of the dual $N = 8$ three-dimensional SCFTs.
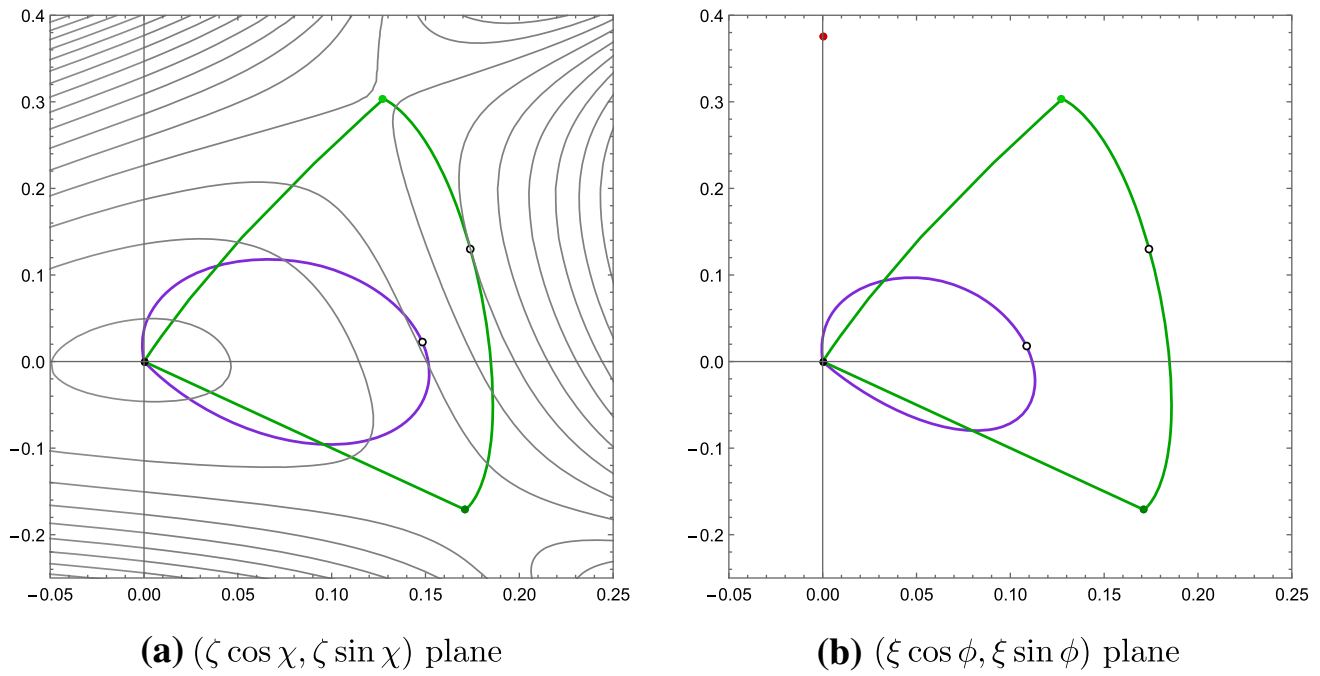
It would be interesting to uplift the $\omega = 0$ solutions involving the $U(3)$ critical point to M-theory and determine the corresponding field theory deformations leading to these interfaces. The field theory description of Janus solutions that flow to a critical point also deserves further study. Embedding the

ω-deformed $SO(8)$ gauged supergravity in higher dimensions is clearly desirable both in the holographic context and in other applications of the dyonic $SO(8)$ gauged supergravity in string/M-theory. In particular, this would allow uplifting both the RG flows of [36,37] and the Janus solutions found in this paper to string/M-theory similar to the study in [42]. It is also interesting to look for similar solutions with $0 < \omega < \frac{\pi}{8}$. In this case, the two equivalent G_2 and $U(3)$ critical points will have different cosmological constants and become physically inequivalent critical points with the same mass spectrum and (super) symmetry. With additional two critical points, there would be many more possible solutions. Moreover, Janus solutions with $\omega \neq 0$ that describe interfaces between conformal and Coulomb phases or between Coulomb phases dual to boundary SCFTs [43] are also worth considering. In four-dimensional gauged supergravities, this type of solutions has been first considered in [20] and later in [22] in $N = 4$ and $N = 8$ gauged supergravities, respectively. We hope to come back to these issues in future work.
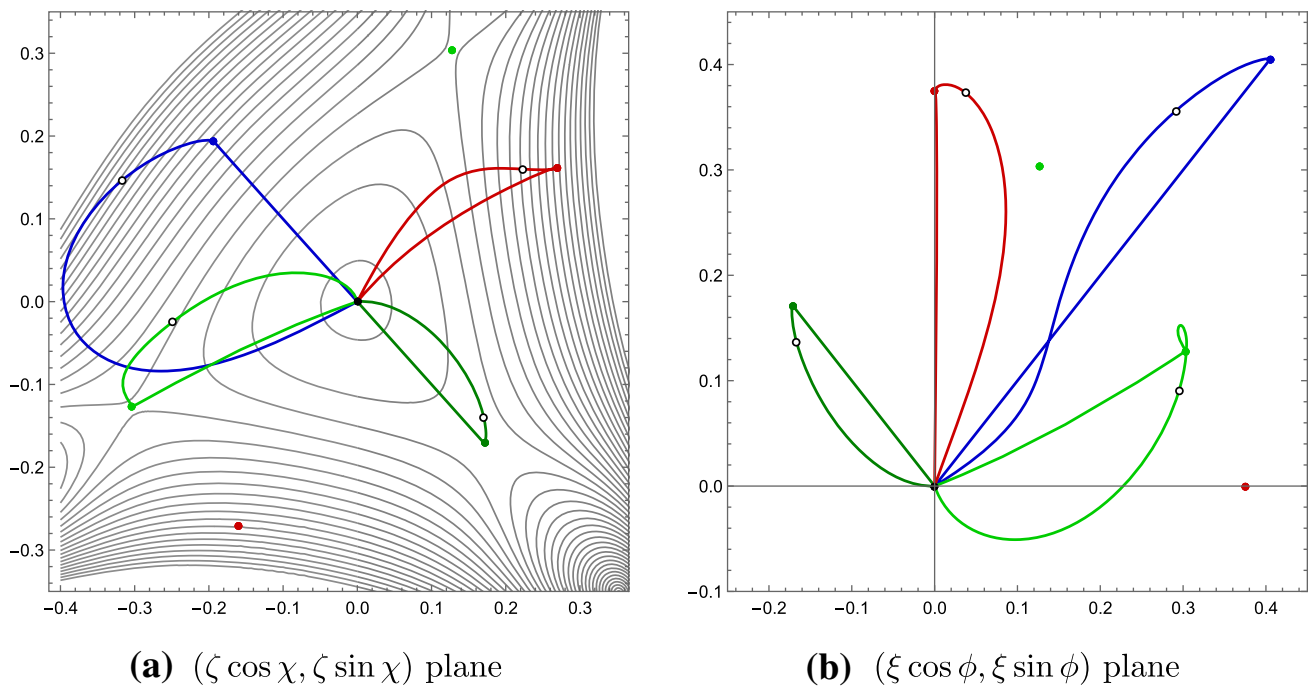
(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 8 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A for $SO(8)/U(3)$ Janus together with $SO(8)/G_2$ and G_2/G_2 solutions that flow to the $U(3)$ critical point as functions of the radial coordinate r
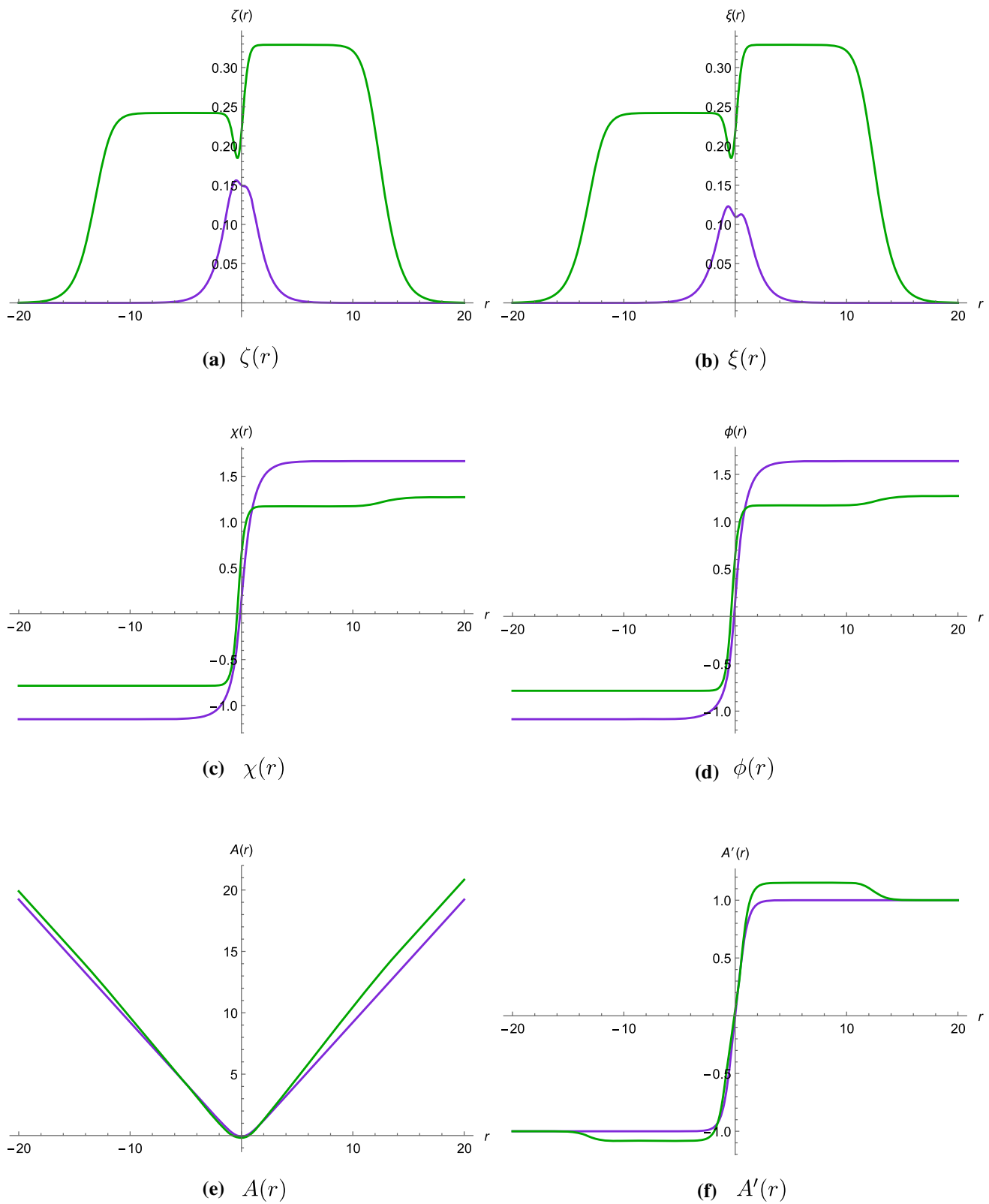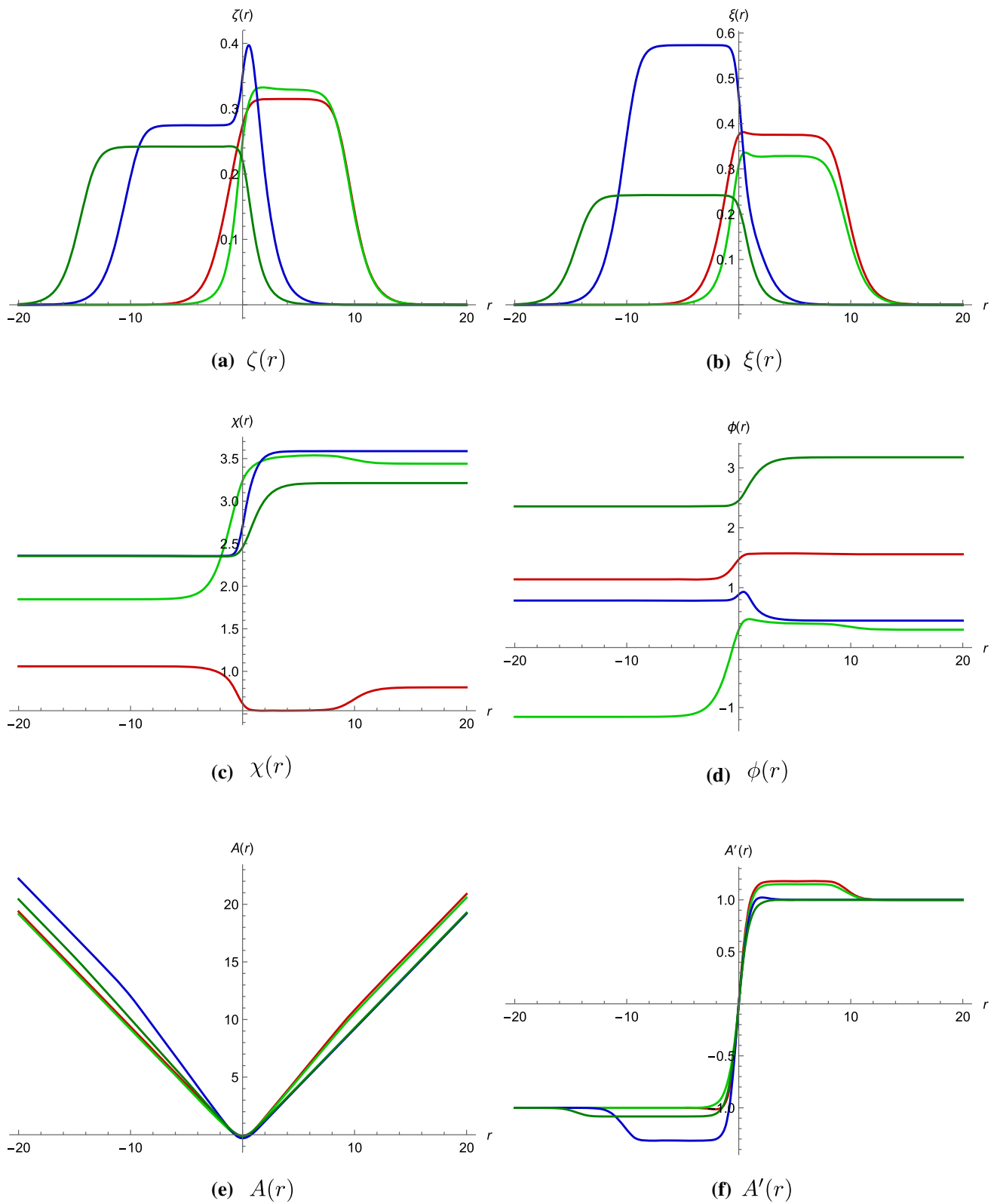
(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane

(b) $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 9 $SO(8)/SO(8)$ and $G_2/\overline{G}_2$ Janus solutions on the contour plot of the superpotential with $\omega = \frac{\pi}{8}$ are shown by purple and green lines, respectively
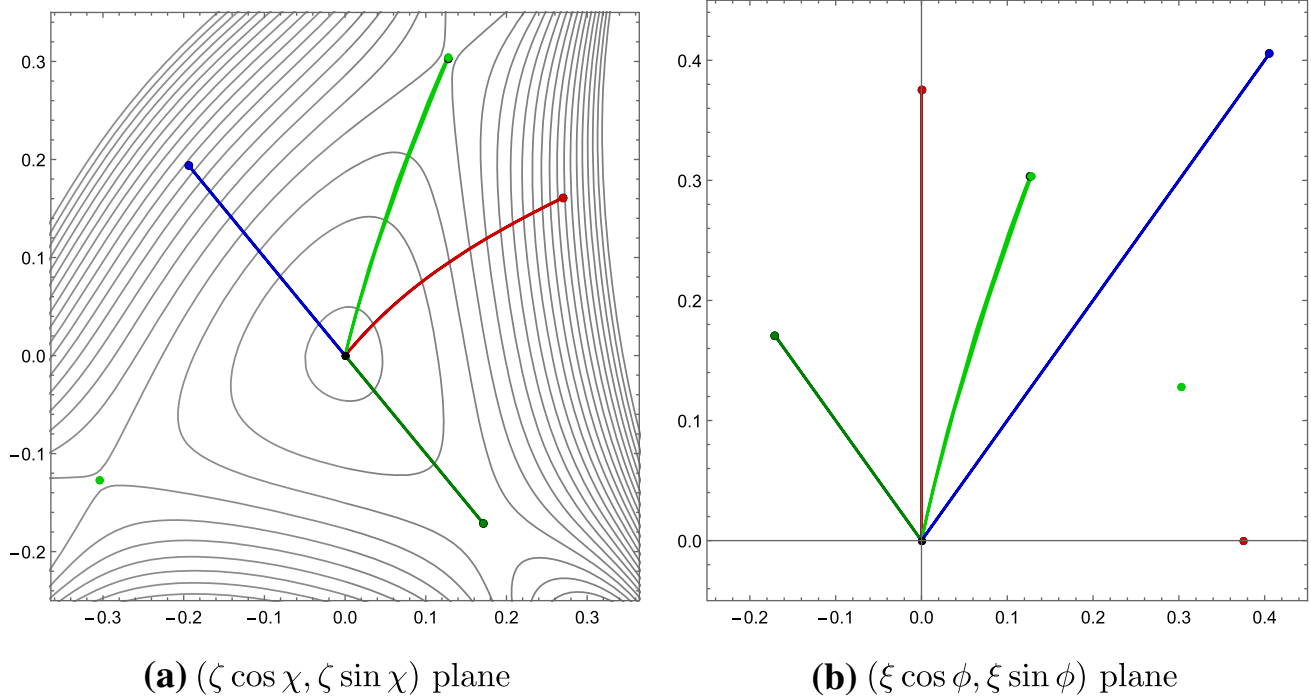

(a) $(\zeta \cos \chi, \zeta \sin \chi)$ plane

(b) $(\xi \cos \phi, \xi \sin \phi)$ plane

Fig. 10 $SO(8)/U(3)$, $SO(8)/G_2$, $SO(8)/\overline{G}_2$ and $SO(8)/SU(3)$ Janus solutions on the contour plot of the superpotential with $\omega = \frac{\pi}{8}$ are shown in red, green, dark green and blue lines, respectively
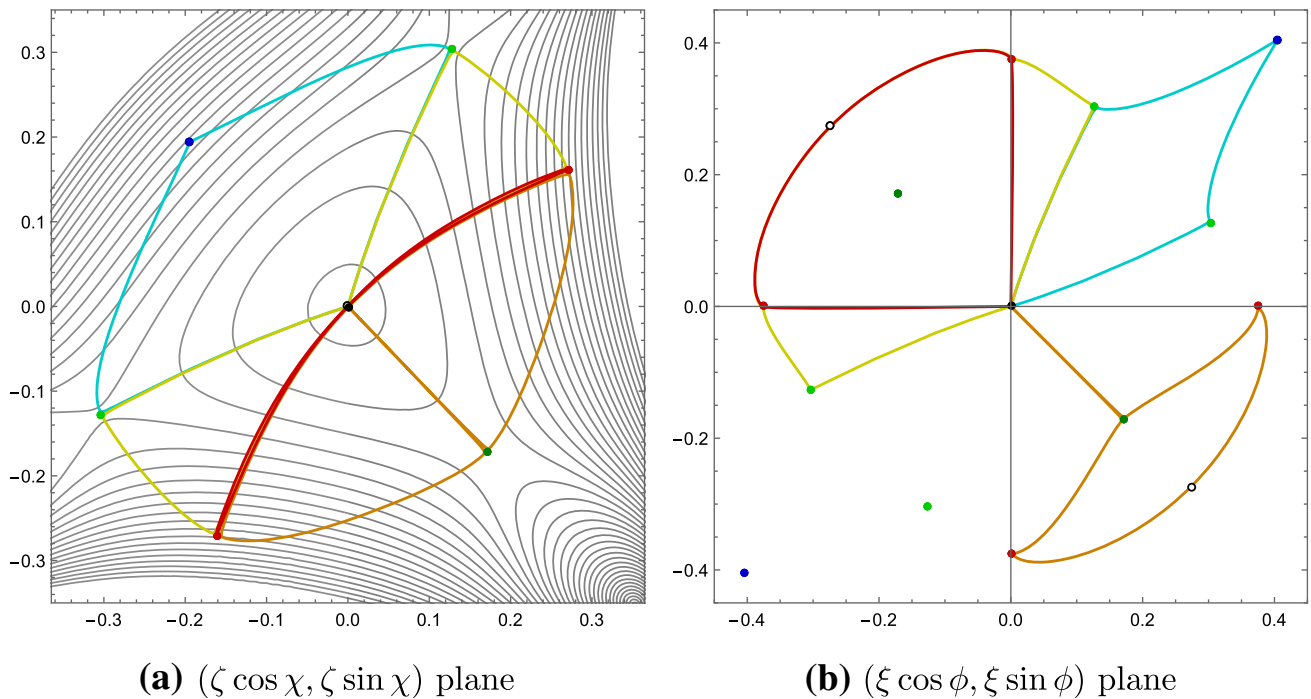
(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 11 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A for $SO(8)/SO(8)$ and $G_2/\overline{G}_2$ Janus solutions with $\omega = \frac{\pi}{8}$ as functions of the radial coordinate r
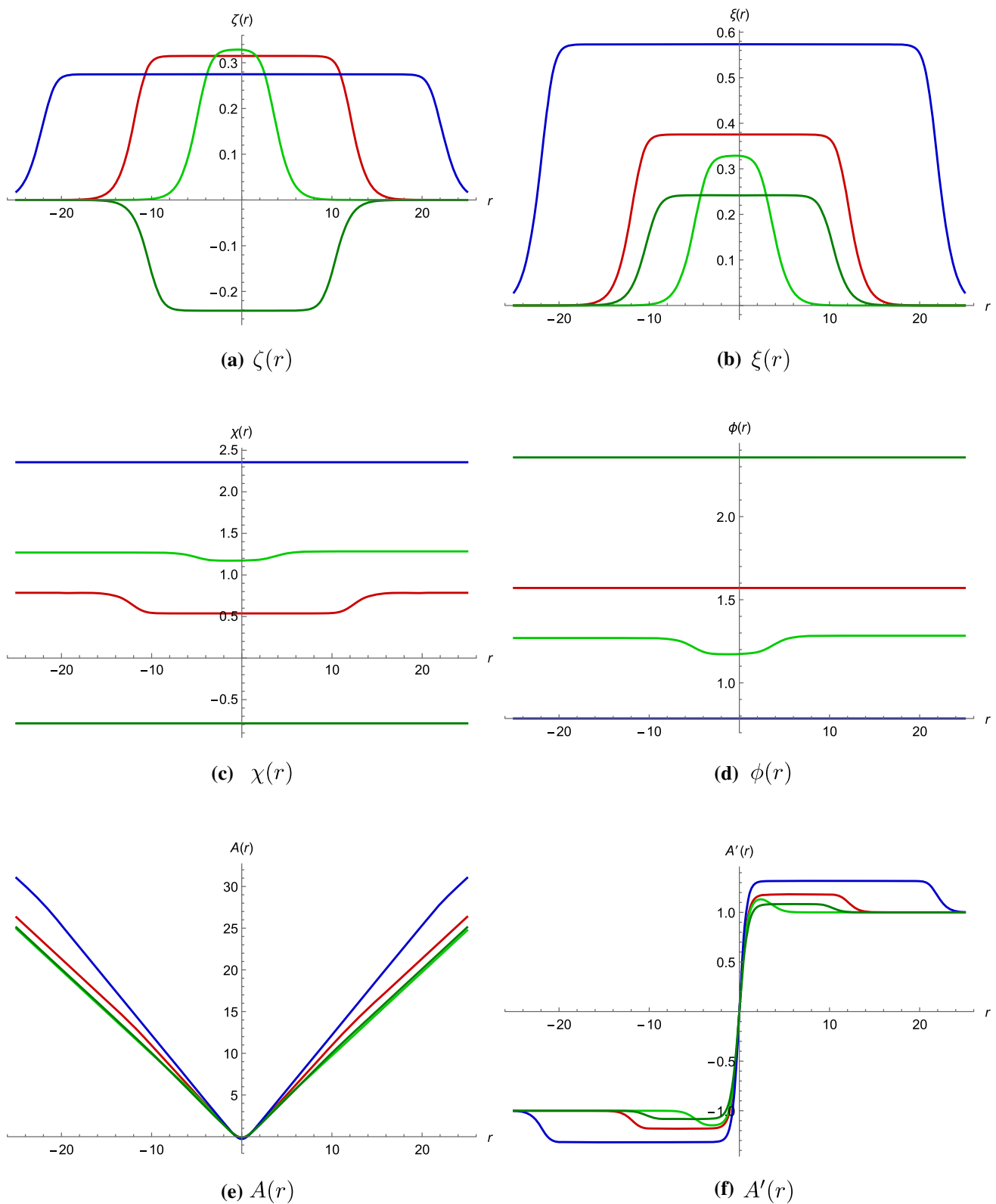
(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 12 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A for $SO(8)/U(3)$, $SO(8)/G_2$, $SO(8)/\overline{G}_2$ and $SO(8)/SU(3)$ Janus solutions with $\omega = \frac{\pi}{8}$ as functions of the radial coordinate r

(a) $(\zeta\cos\chi, \zeta\sin\chi)$ plane

(b) $(\xi\cos\phi, \xi\sin\phi)$ plane

Fig. 13 $SO(8)/SO(8)$ Janus solutions that flow to $U(3)$, G_2, $\overline{G}_2$ and $SU(3)$ critical points with $\omega = \frac{\pi}{8}$ are shown on the contour plot of the superpotential by red, green, dark green and blue lines, respectively
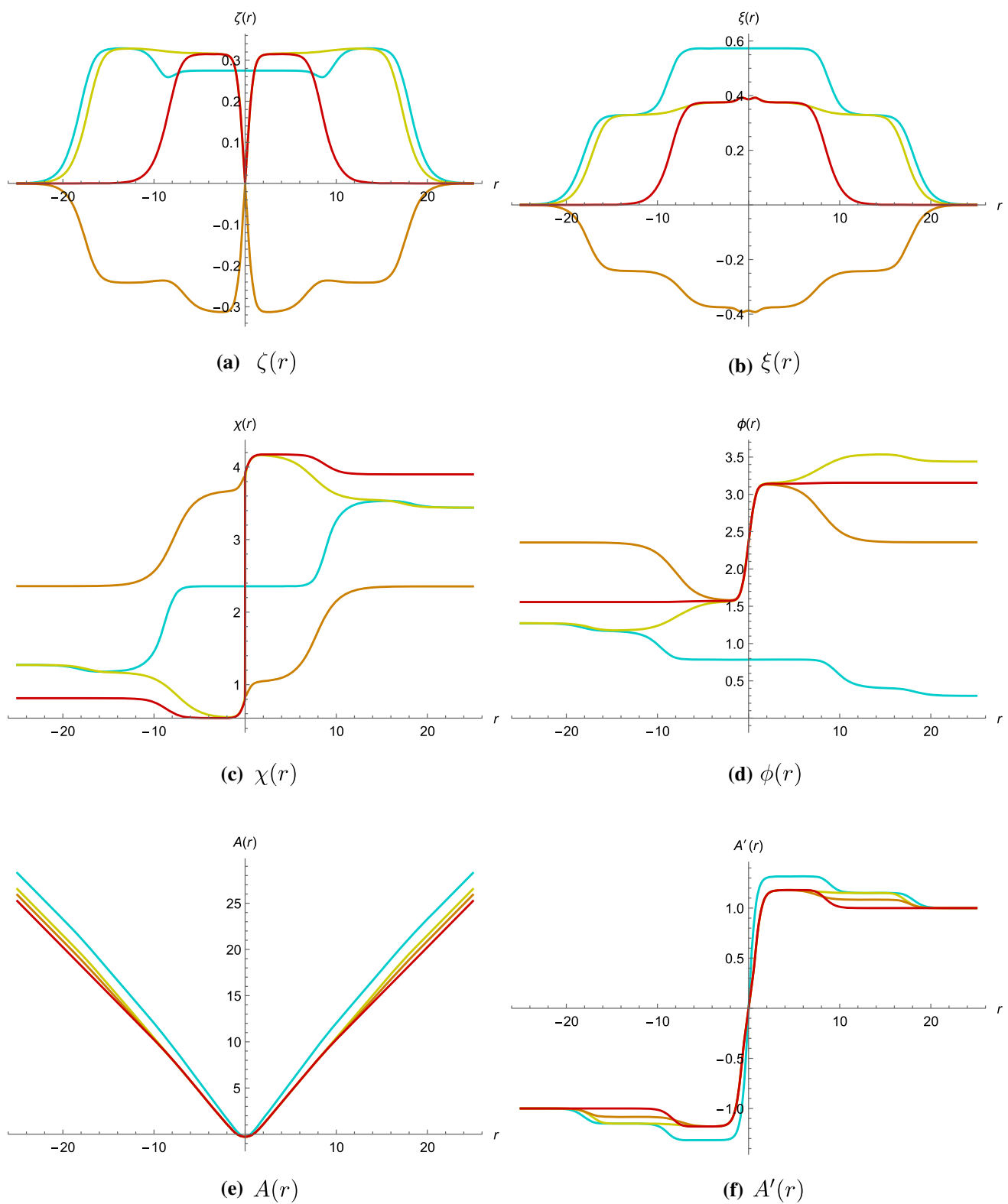

(a) $(\zeta\cos\chi, \zeta\sin\chi)$ plane

(b) $(\xi\cos\phi, \xi\sin\phi)$ plane

Fig. 14 G_2/G_2 Janus solutions that flow to $SU(3)$ (blue) and $U(3)$ (yellow) critical points are shown on the contour plot of the superpotential with $\omega = \frac{\pi}{8}$. The red line represents a $U(3)/U(3)$ Janus, and the orange line corresponds to a $\overline{G}_2/\overline{G}_2$ solution that flows to the $U(3)$ critical point

(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 15 Profiles of scalar fields (ζ, ξ, χ, ϕ) and of the warped factor A for $SO(8)/SO(8)$ Janus solutions that flow to $U(3)$, G_2, $\overline{G}_2$ and $SU(3)$ critical points with $\omega = \frac{\pi}{8}$ as functions of the radial coordinate r

(a) $\zeta(r)$

(b) $\xi(r)$

(c) $\chi(r)$

(d) $\phi(r)$

(e) $A(r)$

(f) $A'(r)$

Fig. 16 Profiles of scalar fields (ζ, ξ, χ, ϕ) and the warped factor A as functions of the radial coordinate r for $U(3)/U(3)$ Janus together with G_2/G_2 and $\overline{G}_2/\overline{G}_2$ solutions that flow to $U(3)$ and $SU(3)$ critical points with $\omega = \frac{\pi}{8}$

Data Availability Statement This manuscript has no associated data or the data will not be deposited. [Authors' comment: This is a theoretical study and no experimental data has been listed.]

References

1. J.M. Maldacena, The large N limit of superconformal field theories and supergravity. Adv. Theor. Math. Phys. **2**, 231–252 (1998). arXiv:hep-th/9711200

2. S.S. Gubser, I.R. Klebanov, A.M. Polyakov, Gauge theory correlators from non-critical string theory. Phys. Lett. B **428**, 105–114 (1998). arXiv:hep-th/9802109

3. E. Witten, Anti De Sitter space and holography. Adv. Theor. Math. Phys. **2**, 253–291 (1998). arXiv:hep-th/9802150

4. D. Bak, M. Gutperle, S. Hirano, A dilatonic deformation of AdS_5 and its field theory dual. JHEP **05**, 072 (2003). arXiv:hep-th/0304129

5. A.B. Clark, D.Z. Freedman, A. Karch, M. Schnabl, Dual of the Janus solution: an interface conformal field theory. Phys. Rev. D **71**, 066003 (2005). arXiv:hep-th/0407073

6. E. D'Hoker, J. Estes, M. Gutperle, Interface Yang–Mills, supersymmetry, and Janus. Nucl. Phys. B **753**, 16 (2006). arXiv:hep-th/0603013

7. D. Gaiotto, E. Witten, Janus configurations, Chern–Simons couplings, and the theta angle in N = 4 super Yang–Mills theory. JHEP **1006**, 097 (2010). arXiv:0804.2907

8. O. DeWolfe, D.Z. Freedman, H. Ooguri, Holography and defect conformal field theories. Phys. Rev. D **66**, 025009 (2002). arXiv:hep-th/0111135

9. A. Clark, A. Karch, Super Janus. JHEP **10**, 094 (2005). arXiv:hep-th/0506265

10. E. D'Hoker, J. Estes, M. Gutperle, Ten-dimensional supersymmetric Janus solutions. Nucl. Phys. B **757**, 79 (2006). arXiv:hep-th/0603012

11. E. D'Hoker, J. Estes, M. Gutperle, Exact half-BPS Type IIB interface solutions. I. Local solution and supersymmetric Janus. JHEP **021**, 06 (2007)

12. M.W. Suh, Supersymmetric Janus solutions in five and ten dimensions. JHEP **09**, 064 (2011). arXiv:1107.2796

13. N. Bobev, F.F. Gautason, K. Pilch, M. Suh, J. van Muiden, Janus and J-fold solutions from Sasaki–Einstein manifolds. Phys. Rev. D **100**, 081901 (2019). arXiv:1907.11132

14. N. Bobev, F.F. Gautason, K. Pilch, M. Suh, J. van Muiden, Holographic interfaces in $N = 4$ SYM: Janus and J-folds. JHEP **05**, 134 (2020). arXiv:2003.09154

15. G. Dall'Agata, G. Inverso, M. Trigiante, Evidence for a family of $SO(8)$ gauged supergravity theories. Phys. Rev. Lett. **109**, 201301 (2012). arXiv:1209.0760

16. G. Dall'Agata, G. Inverso, A. Marrani, Symplectic deformations of gauged maximal supergravity. JHEP **07**, 133 (2014). arXiv:1405.2437

17. B. de Wit, H. Nicolai, $N = 8$ Supergravity. Nucl. Phys. B **208**, 323 (1982)

18. N. Bobev, K. Pilchand, N.P. Warner, Supersymmetric Janus solutions in four dimensions. JHEP **058**, 1406 (2014). arXiv:1311.4883

19. P. Karndumri, Supersymmetric Janus solutions in four-dimensional $N = 3$ gauged supergravity. Phys. Rev. D **93**, 125012 (2016). arXiv:1604.06007

20. P. Karndumri, Supersymmetric deformations of 3D SCFTs from tri-sasakian truncation. Eur. Phys. J. C **77**, 130 (2017). arXiv:1610.07983

21. P. Karndumri, K. Upathambhakul, Supersymmetric RG flows and Janus from type II orbifold compactification. Eur. Phys. J. C **77**, 455 (2017). arXiv:1704.00538

22. M. Suh, Supersymmetric Janus solutions of dyonic $ISO(7)$-gauged $N = 8$ supergravity. JHEP **04**, 109 (2018). arXiv:1803.00041

23. N. Kim, S.J. Kim, Re-visiting supersymmetric Janus solutions: a perturbative construction. Chin. Phys. C **44**(7), 073104 (2020). arXiv:2001.06789

24. P. Karndumri, C. Maneerat, Supersymmetric solutions from $N = 5$ gauged supergravity. Phys. Rev. D **101**, 126015 (2020). arXiv:2003.05889

25. P. Karndumri, J. Seeyangnok, Supersymmetric solutions from $N = 6$ gauged supergravity. arXiv:2012.10978

26. C. Bachas, J. de Boer, R. Dijkgraaf, H. Ooguri, Permeable conformal walls and holography. JHEP **06**, 027 (2002). arXiv:hep-th/0111210

27. C. Bachas, M. Petropoulos, Anti-de-Sitter D-branes. JHEP **02**, 025 (2001). arXiv:hep-th/0012234

28. D. Bak, M. Gutperle, S. Hirano, Three dimensional Janus and time-dependent black holes. JHEP **02**, 068 (2007). arXiv:hep-th/0701108

29. M. Chiodaroli, M. Gutperle, D. Krym, Half-BPS solutions locally asymptotic to $AdS_3 \times S^3$ and interface conformal field theories. JHEP **02**, 066 (2010). arXiv:0910.0466

30. M. Chiodaroli, E. D'Hoker, Y. Guo, M. Gutperle, Exact half-BPS string-junction solutions in six-dimensional supergravity. JHEP **086**, 12 (2011). arXiv:1107.1722

31. D. Bak, H. Min, Multi-faced Black Janus and entanglement. JHEP **03**, 046 (2014). arXiv:1311.5259

32. E. D'Hoker, J. Estes, M. Gutperle, D. Krym, Janus solutions in M-theory. JHEP **06**, 018 (2009). arXiv:0904.3313

33. M. Gutperle, J. Kaidi, H. Raj, Janus solutions in six-dimensional gauged supergravity. JHEP **12**, 018 (2017). arXiv:1709.09204

34. K. Chen, M. Gutperle, Janus solutions in three-dimensional N = 8 gauged supergravity. arXiv:2011.10154

35. A. Borghese, G. Dibitetto, A. Guarino, D. Roest, O. Varela, The $SU(3)$-invariant sector of new maximal supergravity. JHEP **03**, 082 (2013). arXiv:1211.5335

36. A. Guarino, On new maximal supergravity and its BPS domain-walls. JHEP **02**, 026 (2014). arXiv:1311.0785

37. J. Tarrio, O. Varela, Electric/magnetic duality and RG flows in AdS_4/CFT_3. JHEP **01**, 071 (2014). arXiv:1311.2933

38. Y. Pang, C.N. Pope, J. Rong, Holographic RG flow in a new $SO(3) \times SO(3)$ sector of ω-deformed $SO(8)$ gauged $N = 8$ supergravity. JHEP **08**, 122 (2015). arXiv:1506.04270

39. A. Borghese, A. Guarino, D. Roest, Triality, periodicity and stability of $SO(8)$ gauged supergravity. JHEP **05**, 107 (2013). arXiv:1302.6057

40. B. de Wit, H. Nicolai, Deformations of gauged $SO(8)$ supergravity and supergravity in eleven dimensions. JHEP **05**, 077 (2013). arXiv:1302.6219

41. N. Warner, Some new extrema of the scalar potential of gauged $N = 8$ supergravity. Phys. Lett. B **128**, 169 (1983)

42. K. Pilch, A. Tyukov, N.P. Warner, $N = 2$ supersymmetric Janus solutions and flows: from gauged supergravity to M theory. JHEP **05**, 005 (2016). arXiv:1510.08090

43. M. Gutperle, J. Samani, Holographic RG-flows and boundary CFTs. Phys. Rev. D **86**, 106007 (2012). arXiv:1207.7325