ECE2 FLUID ELECTRODYNAMICS

by

M. W. Evans and H. Eckardt

Civil List and AIAS /UPITEC

(www.archive.org, www.webarchive.org.uk, www.aias.us, www.upitec.org, www.et3m.net)

ABSTRACT

The field equations of fluid electrodynamics, a new subject area, are derived from Cartan geometry. The Reynolds number is incorporated into the field equations, allowing the computation of transition to turbulence. In fluid electrodynamics, spacetime is characterized by a mass / current density and a charge / current density. This means that the "missing mass" of the obsolete physics can be accounted for without dark matter. Electric power from spacetime is a direct consequence of fluid electrodynamics. It is shown that the Stokes and convective derivatives of fluid dynamics and electrodynamics are examples of the Cartan covariant derivative. The spin connection for the convective derivative is the Jacobian, and is a foundational concept both of fluid dynamics and fluid electrodynamics. Numerical solutions of key equations illustrate the fluid flows of spacetime (or "aether" or "vacuum").

Keywords: ECE2, fluid electrodynamics, numerical solutions.

4FT 351

1. INTRODUCTION

In recent papers of this series {1-12} the ECE2 unified field theory, initiated in UFT313, has been applied to precession in astronomy and to fluid dynamics, giving many original insights. Kambe (keywords "Fluid Maxwell's equations" on google) has recently rearranged the equations of fluid dynamics into a format which is translated in this paper into equations of ECE2 electrodynamics. The end result is named "fluid electrodynamics", the combination of two very large subject areas made possible by the fact that ECE2 is a unified field theory. Similarly, there are equations of "fluid gravitation", and "fluid nuclear theory".

This paper is a short synopsis of detailed calculations contained in the accompanying notes, posted with UFT351 on www.aias.us. Note 351(1) is a detailed description of the Kambe field equations of fluid dynamics, which have the same geometrical structure as the ECE2 field equations both of electrodynamics and of gravitation. The Reynolds number, omitted by Kambe, is reinstated. Notes 351(2) to 351(4) give a list of conversion factors which are used to translate the Kambe field equations into fluid electrodynamics, and give the main equations. Notes 351(5) to 351(7) show that the Stokes and convective derivatives of fluid dynamics are examples of the Cartan covariant derivative of geometry. It is shown that the spin connection of the convective derivative is the Jacobian. Finally, note 351(8) incorporates the vorticity equation with Reynolds number into the field equations of Kambe, and derives new equations that govern the transition to turbulence.

Section 2 derives the main equations of fluid electrodynamics and gives a list of conversion factors. It is shown that energy from spacetime is a direct consequence of fluid electrodynamics and that spacetime is a richly structured fluid - the "aether" or "vacuum".

Section 3 gives numerical solutions that directly illustrate spacetime flow and the development of turbulence.

2. MAIN FIELD EQUATIONS OF FLUID ELECTRODYNAMICS

The minimal prescription can be used to show that for a single particle:

$$\underline{v} = \frac{e}{m}\underline{A} \qquad -(1)$$

where $\underline{v}$ is linear velocity, e and m the charge and mass of the particle, and $\underline{A}$ the conventional vector potential. In ECE2 $\underline{A}$ is replaced by $\underline{W}$. For a fluid field, a continuum:

$$\underline{v} = \frac{\rho}{\rho_m}\underline{A} \qquad -(2)$$

where ρ is the charge density and ρ_m is the mass density. The basic S. I. Units are as follows:

$$\begin{aligned}
\underline{E} &= \text{volt } m^{-1} = J C^{-1} m^{-1} = \text{electric field strength} \\
\underline{W} &= J s C^{-1} m^{-1} = \text{vector potential} \\
\phi_W &= J C^{-1} = \text{volt} = \text{scalar potential} \\
\underline{B} &= J s C^{-1} m^{-2} = \text{tesla} = \text{magnetic flux density} \\
\rho &= \text{charge density} = C m^{-3} \\
\underline{J} &= \text{current density} = C m^{-2} s^{-1} \\
\epsilon_0 &= \text{vacuum permittivity} = J^{-1} C^2 m^{-1} \\
\mu_0 &= \text{vacuum permeability} = J s^2 C^{-2} m^{-1}.
\end{aligned} \qquad -(3)$$

The Kambe field equations of fluid dynamics are converted into the equations of fluid electrodynamics as follows.

Kambe's fluid electric field is defined as:

$$\underline{E}_F = -\frac{\partial \underline{v}}{\partial t} - \underline{\nabla} h = (\underline{v}\cdot\underline{\nabla})\underline{v} \qquad -(4)$$

where the velocity field is:

$$\underline{v} = v\left(x(t), y(t), z(t), t\right) \quad -(5)$$

and where the following definition is used of enthalpy per unit mass h in joules per kilogram:

$$\underline{\nabla} h = \frac{1}{\rho_m} \underline{\nabla} \underline{p} . \quad -(6)$$

Here $\underline{p}$ is pressure, defined with non standard units. In ECE2 unified field theory the electric field strength in volts per metre is defined as:

$$\underline{E} = -\underline{\nabla}\phi_W - \partial \underline{W} / \partial t \quad -(7)$$

From Eqs. (4) and (7):

$$\underline{W} = \frac{\rho_m}{\rho} \underline{v} \quad -(8)$$

It follows that:

$$\phi_W = \frac{\rho_m}{\rho} h \quad -(9)$$

in units of joules per coulomb.

Kambe's fluid magnetic field is defined to be the vorticity:

$$\underline{H}_F = \underline{w} = \underline{\nabla} \times \underline{v} \quad -(10)$$

and it follows that:

$$\underline{\nabla} \cdot \underline{H}_F = \underline{\nabla} \cdot \underline{w} = 0. \quad -(11)$$

Kambe's charge q and current $\underline{J}$ are defined respectively as:

$$q_F = \underline{\nabla} \cdot \underline{E}_F = \underline{\nabla} \cdot \left(\left(\underline{v} \cdot \underline{\nabla} \right) \underline{v} \right) \quad -(12)$$

and

$$\underline{J}_F = \frac{\partial^2 \underline{v}}{\partial t^2} + \underline{\nabla} \frac{\partial h}{\partial t} + a_0^2 \, \underline{\nabla} \times \left(\underline{\nabla} \times \underline{v} \right) \quad -(13)$$

It follows that the charge density ρ and the current density $\underline{J}$ of fluid electrodynamics are defined as:

$$\rho = \epsilon_0 \frac{\rho_m}{\rho} q_F \quad -(14)$$

and

$$\underline{J} = \epsilon_0 \frac{\rho_m}{\rho} \underline{J}_F . \quad -(15)$$

Therefore the Coulomb law of fluid electrodynamics is:

$$\underline{\nabla} \cdot \left(\frac{\rho}{\rho_m} \underline{E} \right) = \frac{\rho}{\rho_m} \underline{\nabla} \cdot \underline{E} + \underline{E} \cdot \underline{\nabla} \left(\frac{\rho}{\rho_m} \right) = \frac{1}{\epsilon_0} \frac{\rho^2}{\rho_m} \quad -(16)$$

and contains more information than the Coulomb law of conventional electrodynamics. The former reduces to the latter if

$$\underline{\nabla} \left(\frac{\rho}{\rho_m} \right) = \underline{0} . \quad -(17)$$

The inhomogeneous field equation of Kambe is:

$$a_0^2 \, \underline{\nabla} \times \underline{H}_F - \frac{\partial \underline{E}_F}{\partial t} = \underline{J}_F \quad -(18)$$

where a_0 is the constant speed of sound. It follows that the Ampère Maxwell law of fluid electrodynamics is:

$$a_0^2 \, \underline{\nabla} \times \left(\frac{\rho}{\rho_m} \underline{B} \right) - \frac{\partial}{\partial t} \left(\frac{\rho}{\rho_m} \underline{E} \right) = \frac{1}{\epsilon_0} \frac{\rho}{\rho_m} \underline{J} \quad -(19)$$

in which:

$$\underline{\nabla} \times \left(\frac{\rho}{\rho_m} \underline{B} \right) = \frac{\rho}{\rho_m} \underline{\nabla} \times \underline{B} + \left(\underline{\nabla} \frac{\rho}{\rho_m} \right) \times \underline{B} \quad -(20)$$

and:
$$\frac{\partial}{\partial t}\left(\frac{\rho}{\rho_m}\underline{E}\right)=\frac{\rho}{\rho_m}\frac{\partial \underline{E}}{\partial t}+\underline{E}\frac{\partial}{\partial t}\left(\frac{\rho}{\rho_m}\right). \quad -(21)$$

Eq. (19) becomes the Ampère Maxwell Law of electrodynamics if:
$$\frac{\partial}{\partial t}\left(\frac{\rho}{\rho_m}\right)=0,\ \underline{\nabla}\left(\frac{\rho}{\rho_m}\right)=\underline{0},\ a_0\rightarrow c, \quad -(22)$$

in which case:
$$\underline{\nabla}\times\underline{B}-\frac{1}{c^2}\frac{\partial \underline{E}}{\partial t}=\mu_0\underline{J}. \quad -(23)$$

Eq. (19) can be written as:
$$\underline{\nabla}\times\underline{B}-\frac{1}{a_0^2}\frac{\partial \underline{E}}{\partial t}=\mu\underline{J} \text{ if } \frac{\partial}{\partial t}\left(\frac{\rho}{\rho_m}\right)=0,\ \underline{\nabla}\left(\frac{\rho}{\rho_m}\right)=\underline{0} \quad -(24)$$

where the fluid permeability is defined by
$$\mu=\frac{1}{\epsilon_0 a_0^2}. \quad -(25)$$

Using Eqs. (18), (14) and (12) the sound equation of fluid electrodynamics is:
$$\frac{\partial^2}{\partial t^2}\left(\frac{\rho}{\rho_m}\underline{E}\right)+a_0^2\,\underline{\nabla}\times\left(\underline{\nabla}\times\left(\frac{\rho}{\rho_m}\underline{E}\right)\right)=-\frac{1}{\epsilon_0}\frac{\partial}{\partial t}\left(\frac{\rho}{\rho_m}\underline{J}\right) \quad -(26)$$

and under conditions (17) and (22) this becomes:
$$\frac{\partial^2\underline{E}}{\partial t^2}+a_0^2\,\underline{\nabla}\times\left(\underline{\nabla}\times\underline{E}\right)=-\frac{1}{\epsilon_0}\frac{\partial \underline{J}}{\partial t}. \quad -(27)$$

In conventional electrodynamics the vacuum is defined by:
$$\rho=0,\ \underline{J}=\underline{0} \quad -(28)$$

but in fluid electrodynamics the vacuum is a richly structured fluid that can create electric and magnetic fields in a circuit such as the Osamu Ide circuit of UFT311.

Therefore to translate the Kambe equations into fluid electrodynamics use:

$$\underline{v} = (\rho/\rho_m)\overline{W} \quad -(29)$$

$$h = (\rho/\rho_m)\phi_W \quad -(30)$$

$$\underline{H}_F = (\rho/\rho_m)\underline{B} \quad -(31)$$

$$\underline{E}_F = (\rho/\rho_m)\underline{E} \quad -(32)$$

$$q_F = \frac{1}{\epsilon_0}\frac{\rho^2}{\rho}. \quad -(33)$$

The units of the quantities used by Kambe are:

$$q_F = s^{-2}, \quad \underline{E}_F = m s^{-2}, \quad \underline{J}_F = m s^{-3}, \quad \underline{H}_F = s^{-1}. \quad -(34)$$

The continuity equation of fluid dynamics is:

$$\frac{\partial \rho_m}{\partial t} + \underline{\nabla} \cdot \underline{J}_m = 0 \quad -(35)$$

where ρ_m is the mass density and $\underline{J}_m$ the current of mass density defined by:

$$\underline{J}_m = \rho_m \underline{v}. \quad -(36)$$

Therefore:

$$\frac{\partial \rho_m}{\partial t} + \rho_m \underline{\nabla} \cdot \underline{v} + \underline{v} \cdot \underline{\nabla} \rho_m = 0. \quad -(37)$$

Kambe transforms Eq. (35) into:

$$\frac{\partial q_F}{\partial t} + \underline{\nabla} \cdot \underline{J}_F = 0 \quad -(38)$$

The continuity equation of ECE2 electrodynamics is:

$$\frac{\partial \rho}{\partial t} + \underline{\nabla} \cdot \underline{J} = 0 \quad -(39)$$

where ρ is the charge density and $\underline{J}$ the current density. It follows that the charge density of fluid electrodynamics is:

$$\rho = \frac{\epsilon_0 \rho_m}{\rho} \nabla V_F \quad -(40)$$

and is a property of the velocity field of the fluid being considered. This can be matter or spacetime, depending on the context or application being considered.

The continuity equation in fluid dynamics is the conservation of matter, which can be neither created nor destroyed in a conservative, classical system. The other well known basic equations of fluid dynamics are conservation of fluid linear momentum (the Euler and Navier Stokes equations); conservation of fluid energy; and conservation of fluid angular momentum (the vorticity equation). The Euler equation given by Kambe is:

$$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + (\underline{v} \cdot \underline{\nabla})\underline{v} = -\frac{1}{\rho} \underline{\nabla} p \quad -(41)$$

and can be developed into the Navier Stokes equation by adding terms on the right hand side as is well known. The convective derivative is defined as:

$$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + (\underline{v} \cdot \underline{\nabla})\underline{v} \quad -(42)$$

and the Stokes derivative is

$$\frac{D\rho}{Dt} = \frac{\partial \rho}{\partial t} + \underline{v} \cdot \underline{\nabla} \rho . \quad -(43)$$

Conservation of fluid energy is defined by Kambe through conservation of entropy per unit mass:

$$\frac{DS}{Dt} = \frac{\partial S}{\partial t} + \underline{v} \cdot \underline{\nabla} S = 0 \quad -(44)$$

Conservation of fluid angular momentum is expressed by Kambe as the vorticity equation:

$$\frac{\partial \underline{w}}{\partial t} + \underline{\nabla} \times (\underline{w} \times \underline{v}) = \underline{0} \quad -(45)$$

and this equation is not used in the derivation of the Kambe field equations. Eq. (45) must be corrected for the Reynolds number R as follows (Note 351(1)):

$$\frac{\partial \underline{w}}{\partial t} + \underline{\nabla} \times (\underline{w} \times \underline{v}) = \frac{1}{R} \nabla^2 \underline{w} \quad -(46)$$

Without the Reynolds number there can be no turbulence or shearing. In general the Kambe equations apply to compressible fluids with viscosity. In incompressible, inviscid fluids:

$$\underline{\nabla} \cdot \underline{v} = 0 \quad -(47)$$

The Kambe field equations are the result of a rearrangement of the fluid dynamical equations describe above. These are all conservation equations fundamental to physics. The rearrangement results in field equations the structure of which is given by Cartan geometry. The same geometry gives ECE2 electrodynamics and gravitation. The foundational Stokes and convective derivatives also originate in Cartan geometry.

The Stokes derivative is:

$$\frac{D\rho}{Dt} = \frac{\partial \rho}{\partial t} + \underline{\nabla}\rho \cdot \underline{v} = \frac{\partial \rho}{\partial t} + \frac{\partial \rho}{\partial X}\frac{dX}{dt} + \frac{\partial \rho}{\partial Y}\frac{dY}{dt} + \frac{\partial \rho}{\partial Z}\frac{dZ}{dt} \quad -(48)$$

where the fluid mass density is:

$$\rho = \rho(X, Y, Z, t) \quad -(49)$$

with:

$$X = X(t),\ Y = Y(t),\ Z = Z(t). \quad -(50)$$

The covariant derivative of Cartan geometry is:

$$\frac{DV^a}{\partial x^\mu} = \frac{\partial V^a}{\partial x^\mu} + \omega^a_{\ \mu b} V^b \quad -(51)$$

where the vector V^a is defined in a tangent spacetime at a point P to the base manifold. The spin connection is in general $\omega^a_{\ \mu b}$. Define the four vector:

$$V^\mu = (c\rho, \underline{v}\rho) \quad -(52)$$

and consider the indices:

$$\mu = 0,\ a = 0. \quad -(53)$$

It follows that:

$$\frac{D\rho}{\partial t} = \frac{\partial \rho}{\partial t} + \omega^0_{\ 01}\rho\frac{dX}{dt} + \omega^0_{\ 02}\rho\frac{dY}{dt} + \omega^0_{\ 03}\rho\frac{dZ}{dt}. \quad -(54)$$

This is the Stokes derivative provided that:

$$\omega^0_{\ 01}\rho = \partial\rho/\partial X,\ \omega^0_{\ 02}\rho = \partial\rho/\partial Y,\ \omega^0_{\ 03}\rho = \partial\rho/\partial Z \quad -(55)$$

i.e. :

$$\underline{\nabla}\rho = \underline{\omega}\rho \quad -(56)$$

where the spin connection vector is:

$$\underline{\omega} = \omega^0_{\ 01}\underline{i} + \omega^0_{\ 02}\underline{j} + \omega^0_{\ 03}\underline{k} \quad -(57)$$

Q. E. D.

Similarly the convective derivative is:

$$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + (\underline{v}\cdot\underline{\nabla})\underline{v} \quad -(58)$$

where the fluid velocity field is:

$$\underline{v} = \underline{v}(x(t), y(t), z(t), t). \quad -(59)$$

The convective derivative is therefore:

$$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + \left(v_x \frac{\partial}{\partial X} + v_y \frac{\partial}{\partial Y} + v_z \frac{\partial}{\partial Z} \right) \underline{v}. \quad -(60)$$

The X component for example is:

$$\frac{Dv_x}{Dt} = \frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial t} + v_y \frac{\partial v_x}{\partial Y} + v_z \frac{\partial v_x}{\partial Z} = \frac{\partial v_x}{\partial t} + \underline{v} \cdot \underline{\nabla} v_x \quad -(61)$$

and similarly for the Y and Z components. Considering

$$\mu = 0 \quad -(62)$$

in Eq. (51) it follows that:

$$\omega^1{}_{01} = \frac{\partial v_x}{\partial X}, \quad \omega^1{}_{02} = \frac{\partial v_x}{\partial Y}, \quad \omega^1{}_{03} = \frac{\partial v_x}{\partial Z} \quad -(63)$$

and in general the spin connection of the convective derivative is the Jacobian:

$$\omega^a{}_{0b} = \frac{\partial v^a}{\partial r^b} \quad -(63a)$$

Q. E. D. So all the equations of fluid dynamics emanate from the spin connection of Cartan geometry, Q. E. D.

Finally the vorticity equation is incorporated in the Kambe field equations as follows.

Kambe's fluid magnetic field is the vorticity:

$$\underline{H}_F = \underline{w} = \underline{\nabla} \times \underline{v} \quad -(64)$$

so: $$\underline{\nabla} \cdot \underline{H}_F = \underline{\nabla} \cdot \underline{w} = 0. \quad -(65)$$

The homogeneous field equation of Kambe is:

$$\underline{\nabla} \times \underline{E}_F + \frac{\partial \underline{H}_F}{\partial t} = \underline{0} \quad -(66)$$

where: $$\underline{H}_F = \underline{w} \quad -(67)$$

and the vorticity equation used by Kambe is:

$$\frac{\partial \underline{w}}{\partial t} + \underline{\nabla} \times (\underline{w} \times \underline{v}) = \underline{0}. \quad -(68)$$

Therefore Kambe's convective derivative is:

$$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + \underline{E}_F. \quad -(69)$$

From Eqs. (66) and (68):

$$\underline{E}_F = \underline{v} \times \underline{w} = (\underline{v} \cdot \underline{\nabla})\underline{v}. \quad -(70)$$

In the particular case of a Beltrami flow:

$$\underline{\nabla} \times \underline{v} = k\underline{v} \quad -(71)$$

where k has the units of inverse metres. So for a Beltrami flow:

$$(\underline{v} \cdot \underline{\nabla})\underline{v} = \underline{0} \quad -(72)$$

and $$\frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t}. \quad -(73)$$

For the general flow Eq. (70) must be solved numerically for v:

$$\underline{v} \times (\underline{\nabla} \times \underline{v}) = (\underline{v} \cdot \underline{\nabla})\underline{v}. \quad -(74)$$

The Reynolds number responsible for turbulent flow enters in to the analysis using:

$$\frac{\partial \underline{w}}{\partial t} + \underline{\nabla} \times (\underline{w} \times \underline{v}) = \frac{1}{R} \nabla^2 \underline{w} \quad -(75)$$

so:

$$\underline{\nabla} \times \underline{E}_F = \frac{1}{R} \nabla^2 \underline{w} - \underline{\nabla} \times (\underline{w} \times \underline{v}). \quad -(76)$$

Now use:

$$\underline{\nabla} \times (\underline{\nabla} \times \underline{w}) = \underline{\nabla}(\underline{\nabla} \cdot \underline{w}) - \nabla^2 \underline{w}. \quad -(77)$$

and

$$\underline{\nabla} \cdot \underline{w} = 0 \quad -(78)$$

to find that:

$$\nabla^2 \underline{w} = -\underline{\nabla} \times (\underline{\nabla} \times \underline{w}). \quad -(79)$$

It follows from Eqs. (76) and (79) that:

$$\underline{E}_F = (\underline{v} \cdot \underline{\nabla})\underline{v} = \underline{v} \times \underline{w} - \frac{1}{R} \underline{\nabla} \times \underline{w}. \quad -(80)$$

Therefore transition to turbulence is governed in general by:

$$\underline{\nabla} \times \underline{w} = -R\left((\underline{v} \cdot \underline{\nabla})\underline{v} - \underline{v} \times \underline{w}\right) \quad -(81)$$

Turbulence in Beltrami flows is defined by:

$$\underline{\nabla} \times \underline{w} = -R(\underline{v} \cdot \underline{\nabla})\underline{v} \quad -(82)$$

Here:

$$\underline{\nabla} \times \underline{w} = \underline{\nabla} \times (\underline{\nabla} \times \underline{v}) = \underline{\nabla}(\underline{\nabla} \cdot \underline{v}) - \nabla^2 \underline{v} \quad -(83)$$

so form Eqs. (82) and (83) turbulence in Beltrami flows is governed by:

$$\nabla^2 \underline{v} = R(\underline{v} \cdot \underline{\nabla})\underline{v} + \underline{\nabla}(\underline{\nabla} \cdot \underline{v}) \quad -(84)$$

which can eb solved numerically using methods described in Section 3.

3. NUMERICAL SOLUTIONS FROM FLOW ALGORITHMS

Section by Dr. Horst Eckardt

ECE2 fluid electrodynamics

M. W. Evans[*], H. Eckardt[†]
Civil List, A.I.A.S. and UPITEC

(www.webarchive.org.uk, www.aias.us,
www.atomicprecision.com, www.upitec.org)

3 Numerical solutions from flow algorithms

The equations (79), (81) and (84) have been solved numerically by the finite element program FlexPDE. The 3D volume was chosen as for typical Navier-Stokes applications: a plenum box with a circular inlet at the bottom and an offset circular outlet at the top, see Fig. 1. The boundary conditions were set to $\mathbf{v} = \mathbf{0}$ at the borders of the box and a directional derivative perpendicular to the openings area was assumed. This allows for a free floating solution of the velocity field. As a test, a solution for the Navier-Stokes equation

$$(\mathbf{v} \cdot \boldsymbol{\nabla})\, \mathbf{v} + \boldsymbol{\nabla} p - \eta \nabla^2 \mathbf{v} = \mathbf{0}. \tag{85}$$

was computed, with η being a viscosity. The pressure term was added because the equation is otherwise homogeneous which means that there is no source term, leading to a solution which does not guarantee conservation of mass. The divergence of the pressure gradient is assumed to be in proportion to the divergence of the velocity field:

$$\boldsymbol{\nabla} \cdot \boldsymbol{\nabla} p = P\, \boldsymbol{\nabla} \cdot \mathbf{v} \tag{86}$$

with a constant P for "penalty pressure". This represents an additional equation for determining the pressure. The result for the velocity is graphed in Fig. 2, showing a straight flow through the box which is perpendicular to the inlet and outlet surfaces as requested by boundary conditions.

Next the vorticity equation (79) was solved, again with the pressure term to guarantee solutions:

$$\nabla^2 \mathbf{w} + \boldsymbol{\nabla} \times (\boldsymbol{\nabla} \times \mathbf{w}) + \boldsymbol{\nabla} p = \mathbf{0}. \tag{87}$$

It is difficult to define meaningful boundary conditions because this is a pure flow equation for the vorticity $\mathbf{w}$. We used the same as for the Navier-Stokes equations. The result is graphed in Fig. 3. There is a flow-like structure with a divergence at the left, the flow is not symmetric. By definition, there should not

[*]email: emyrone@aol.com
[†]email: mail@horst-eckardt.de

be a divergence because of Eq. (78). We assume that the boundary conditions are not adequate for this type of equation.

The situation is more meaningful for Eq. (81) which we solved as

$$\boldsymbol{\nabla} \times \mathbf{w} + R\left(\left(\mathbf{v} \cdot \boldsymbol{\nabla}\right) \mathbf{v} - \mathbf{v} \times \mathbf{w}\right) + \boldsymbol{\nabla} p = \mathbf{0}. \tag{88}$$

The solution for $R = 1$ gives an inclined input and output flow (Fig. 4). In the middle hight of the box the flow is more over the sides, therefore the intensity of velocity is low in the middle plane shown. The divergence (not shown) is practically zero in this region. Fig. 5 shows a divergent and convergent flow in the XY plane, the flow goes over the full width of the box. Results for higher Reynolds numbers show no significant difference.

Finally we solved Eq. (84) which holds for a Beltrami flow:

$$\nabla^2 \mathbf{v} - R\left(\mathbf{v} \cdot \boldsymbol{\nabla}\right) \mathbf{v} - \boldsymbol{\nabla}\left(\boldsymbol{\nabla} \cdot \mathbf{v}\right) + \boldsymbol{\nabla} p = \mathbf{0}. \tag{89}$$

Here the flow is strongly enhanced in the middle region (Fig. 6). In the perpendicular plane a similar effect can be seen (Fig. 7). The field is not divergence-free there. For a Beltrami field we should have

$$\mathbf{w} \times \mathbf{v} = k\mathbf{v} \times \mathbf{v} = \mathbf{0}. \tag{90}$$

The vorticity $\mathbf{w}$ corresponding to Fig. 7 has been graphed in Fig. 8. There are indeed large regions where both $\mathbf{w}$ and $\mathbf{v}$ are parallel or antiparallel. The factor k seems to be location dependent, we did not constrain the Beltrami property by further means. Therefore the result is satisfactory. For larger R values the results remain similar again.

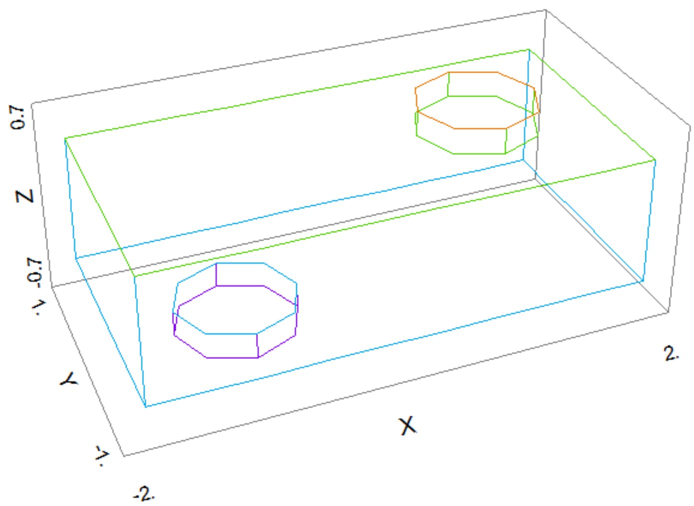

Figure 1: Geometry of FEM calculations.

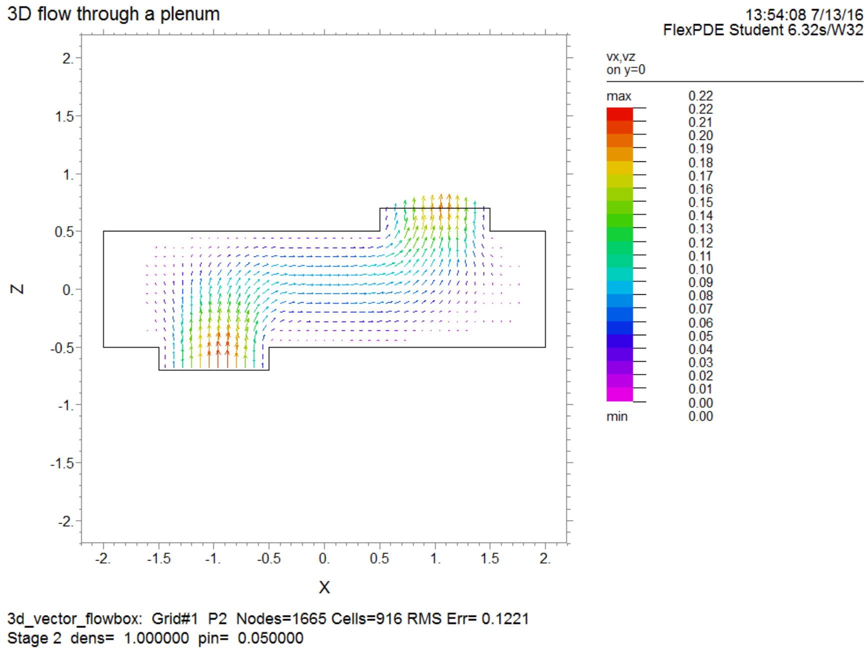

Figure 2: Velocity solution for Naview-Stokes Equation (85).

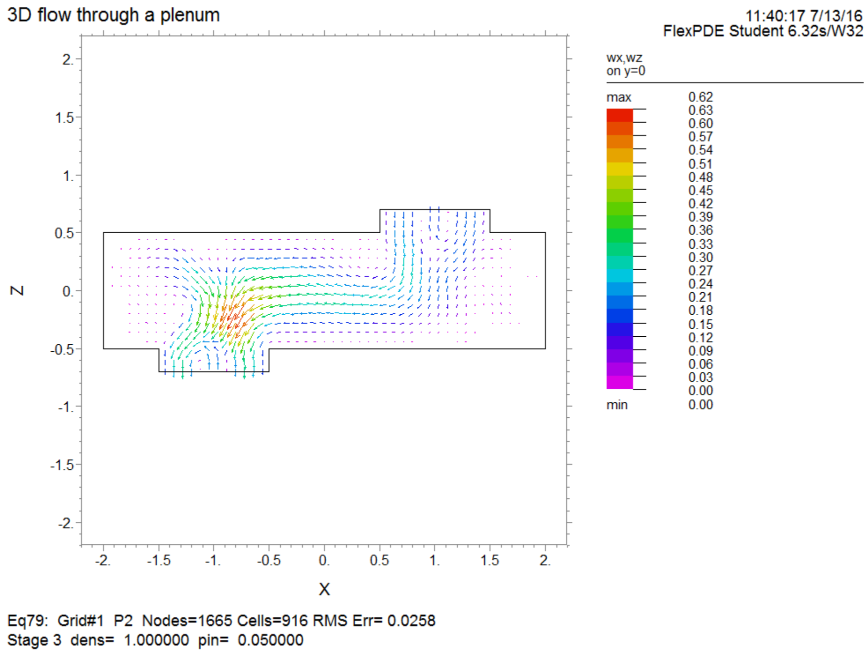

Figure 3: Vorticity solution for Equation (87).

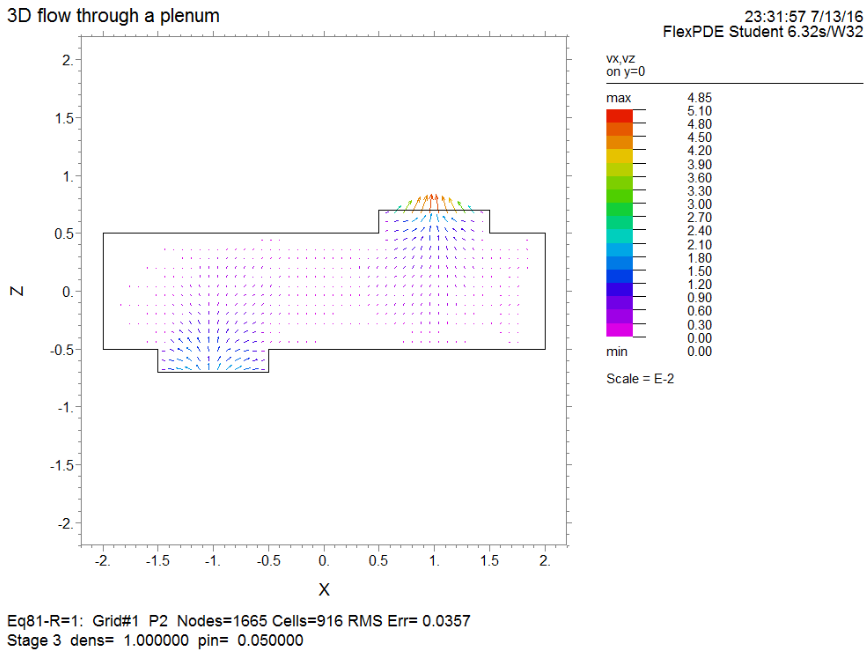

Figure 4: Velocity solution of Eq. (88) for $R = 1$, plane $Y = 0$.

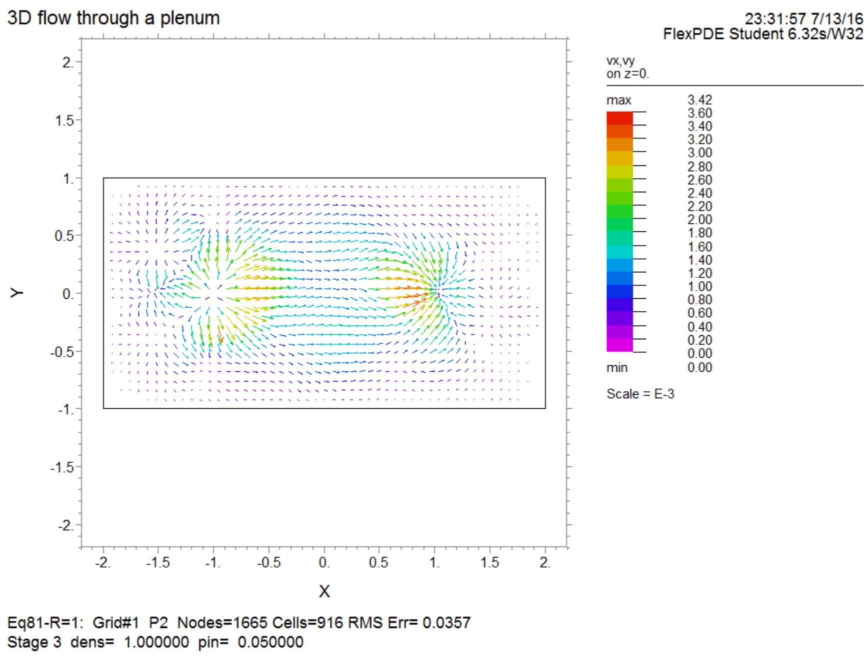

Figure 5: Velocity solution of Eq. (88) for $R = 1$, plane $Z = 0$.

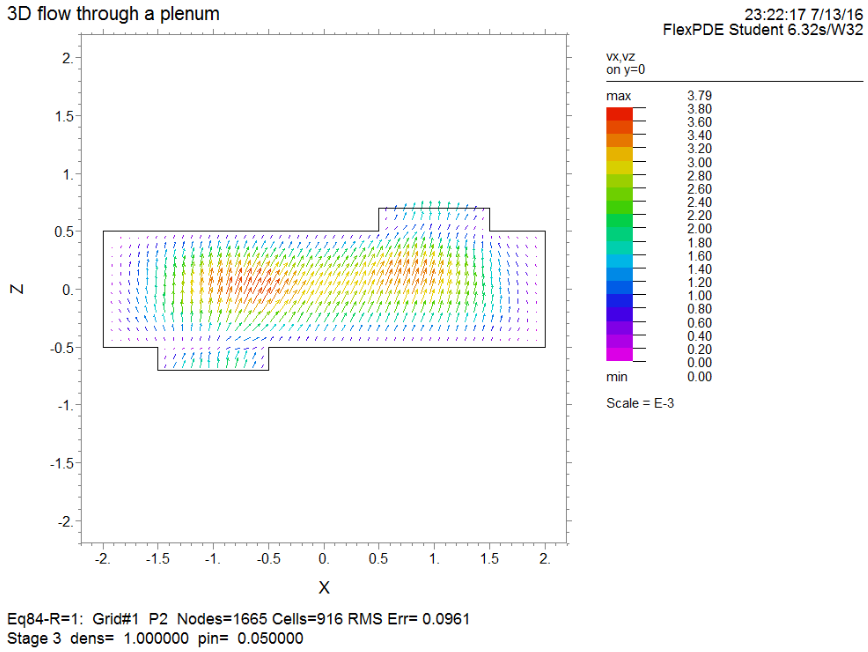

Figure 6: Beltrami solution of Eq. (89) for $R = 1$, plane $Y = 0$.

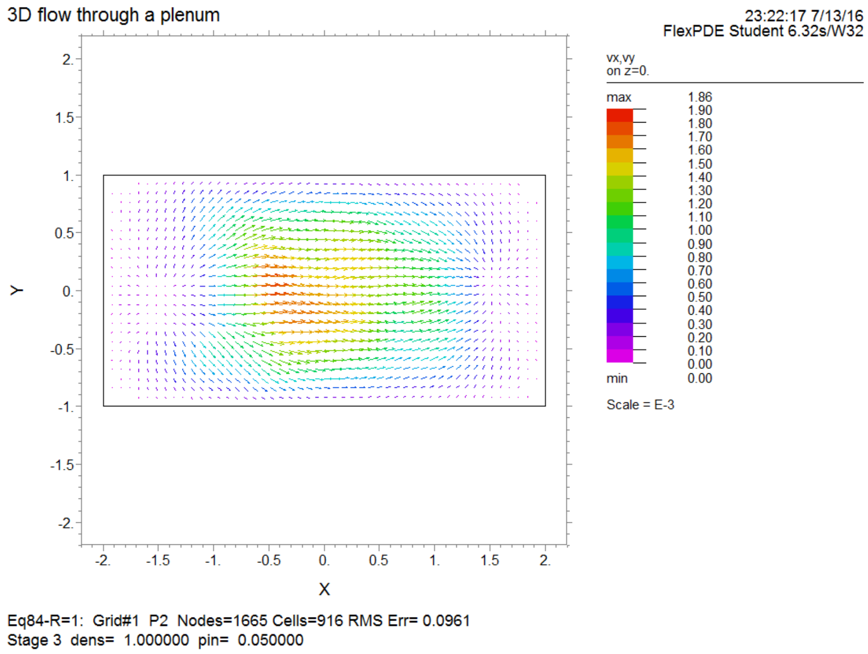

Figure 7: Beltrami solution of Eq. (89) for $R = 1$, plane $Z = 0$.

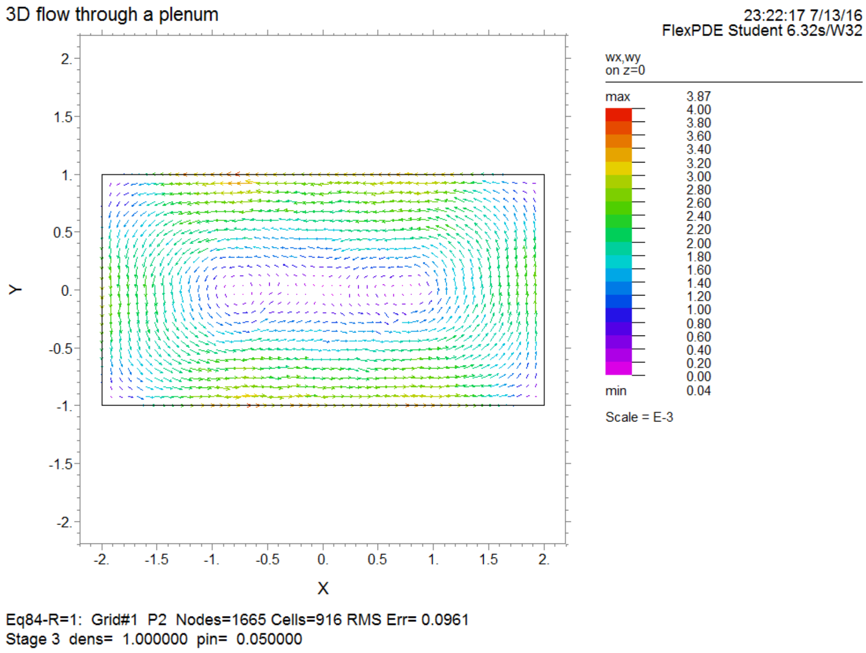

Figure 8: Vorticity of solution for Eq. (89) for $R = 1$, plane $Z = 0$.

ACKNOWLEDGMENTS

The British Government is thanked for a Civil List Pension and the staff of AIAS and others for many interesting discussions. Dave Burleigh, CEO of Annexa Inc., is thanked for hosting www.aias.us, site maintenace, posting and feedback software and maintenance. Alex Hill is thanked for translation and broadcasting, and Robert Cheshire for broadcasting.

REFERENCES

{1} M. W. Evans, H. Eckardt, D. W. Lindstrom and S. J. Crothers, "Principles of ECE Theory" (open source on www.aias.us and www.upitec.org and New Generation, London in prep., translated into Spanish by Alex Hill, open souce on www.aias.us)

{2} M. W. Evans, S. J. Crothers, H. Eckardt and K. Pendergast, "Criticisms of the Einstein Field Equation" (open source as UFT301, Cambridge International (CISP), 2010).

{3} M .W. Evans, H. Eckardt and D. W. Lindstrom, "Genreally Covariant Unified Field Theory" (Open source as UFT papers and Abramis 2005 to 2011) in seven volumes softback.

{4} L. Felker, "The Evans Equations of Unified Field Theory" (open source as UFT302 and Abramis 2007, translated by Alex Hill).

{5} H. Eckardt, "The ECE Engineering Model" (open source as UFT303).

{6} M. W. Evans, "Collected Scientometrics" (open source as UFT307 and New Generation, London, 2015).

{7} M. W. Evans, Ed., J. Found. Phys Chem., (open source as UFT papers and CISP 2011).

{8} M. W. Evans, Ed., "Definitive Refutations of the Einsteinian Genreal Relativity", special topical issue of ref. (7), open source .

{9} M. W. Evans and L. B. Crowell, "Classical and Quantum Electrodynamics and the B(3) Field" (open source Omnia Opera section of www.aias.us and www.upitec.org, , World

Scientific 2001).

{10} M. W. Evans and S. Kielich, Eds., "Modern Nonlinear Optics" (Wiley Interscience, New York, 1992, 1993, 2001) in two editions and six volumes.

{11} M. W. Evans and J. - P. Vigier, "The Enigmatic Photon" (Open source, Omnia Opera section of www.aias.us and Kluwer 1994 to 2002) in five volumes each hardback and softback.

{12} M .W. Evans and A. A. Hasanein, "The Photomagneton in Quantum Field Theory" (World Scientific 1994)