



What Did Emeagwali Discover? – Part 13

In this, the 13th installment of our weekly series at emeagwali.com, we review how Philip Emeagwali created new mathematics.

Where Did Mathematics Come From?

Transcribed and edited from a lecture delivered by [Philip Emeagwali](http://emeagwali.com). The unedited [video](#) is posted at emeagwali.com.

I created a new form of mathematics from a rule that governs the motion of all objects in our universe. The rule is called the Second Law of Motion and the mathematics is called partial differential equation.

“Where did mathematics come from?” you might have wondered. Behind biology is chemistry; behind chemistry is physics; behind physics is mathematics; and behind mathematics is God who created biology. For me, the equations of mathematical physics I created came from physics.

As a research mathematical physicist, my primary goals were to discover useful mathematical equations that hadn't been seen before on a blackboard, and, I invented theorized techniques, called algorithms, for solving them on a hyperboard, comprised of 65,536 connected motherboards.

My theorized algorithms are explanations based on mathematical reasoning of how the partial differential equations I invented can be solved on sub-computers connected as an internet. The final step of solving my equations on an internet with sub-computers at its nodes is mandatory because, according to the scientific method, a theory is an idea that is not positively true.

I wanted to make scientific discoveries and knew I must go beyond theorizing. So I made a clear distinction between my *theories*, which were nine equations and nine algorithms I wrote on my blackboards, and my *facts*, which were 24 million equations—a world record in 1989—I solved with my nine algorithms on my 65,536 connected motherboards.

Thus my ensemble of 65,536 sub-computers that are connected as an internet cannot be considered to be invented as an internet until it is experimentally demonstrated that it computes as a supercomputer and communicates as an internet while solving useful problems.



This photo was taken in the year I morphed from being a mathematical physicist who creates new mathematics to a supercomputer scientist that performed the world's fastest computations. [Philip Emeagwali, 1983]

I learned to distinguish between experiment and theory, between fact and fiction, and between theory and discovery, and to invent algorithms grounded on equations, and formulate equations grounded on the laws of physics, and, most importantly, to hear and trust my inner voice.

I also needed to develop technologies for solving my new equations on a giant, distributed motherboard which I did by programming an ensemble of 65,536 sub-computers that computed cohesively as an unconventional supercomputer and communicated seamlessly in an unorthodox internet. I used these techniques and technologies to solve the nine partial differential equations that I invented.



This is the publicity photo for a lecture I gave on July 8, 1991 at ICIAM 91, which is the World Cup of Mathematics. I told the field's foremost experts that my new mathematics came from inside a petroleum reservoir. [Philip Emeagwali, 1990]

So where did mathematics come from? The mathematical equations I invented came from the physics of petroleum reservoirs. The 72 mathematical terms I invented came from the inertial forces that I discovered were missing in petroleum reservoir simulators. So my mathematics came from oilfields.

I invented 36 partial derivatives and used them to reinvent nine partial differential equations that can be used by the petroleum industry to recover oil. My equations were the most advanced and the most useful form of calculus. I invented them by borrowing the algebraic formula, force equals mass times acceleration ($F=ma$), from Isaac Newton, who lived three centuries ago in England.

Newton invented $F=ma$ by borrowing algebraic knowledge from Mohammad Bin Musa Al-Khwarizmi, the father of algebra, who lived nine centuries earlier in Bagdad. Newton also co-invented calculus by borrowing geometrical knowledge from Euclid, the father of geometry, who lived twenty centuries earlier in the Valley of the River Nile. Euclid's book, *The Elements*, in turn, was influenced by Ahmes Papyrus, which was compiled by Ahmes, who lived fourteen centuries before Euclid in the Valley of the Nile.

Certainly, the quadratic equation did not spontaneously create itself and was not known to our hunter-gatherer ancestors. So "Where did mathematics come from?" It came from both the Nile Valley civilization of Africa and the Tigris-Euphrates civilization of Mesopotamia, a region corresponding to modern Iraq and parts of Syria, Turkey, and Iran.

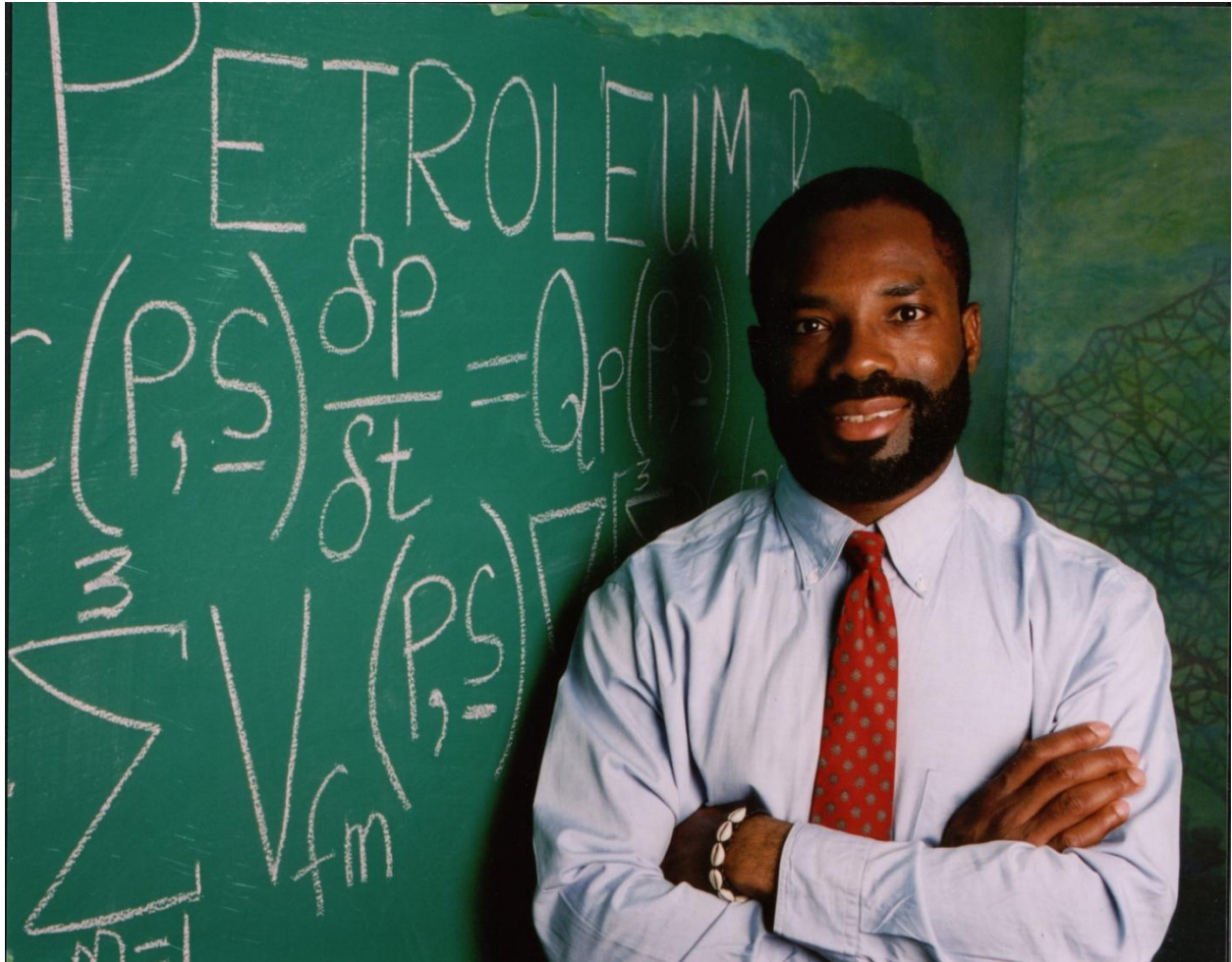
Since the oldest mathematical papyri were excavated in Africa, I assume that mathematics has its roots in Africa. Since Euclid, the father of geometry, never travelled outside the Nile Valley, I assume that geometry has its roots in the Nile Valley of Africa. Since Euclid lived in a predominately black city, I assume that he is black. The portrait of Euclid, as white, in textbooks is a figment of the painter's imagination.

For me, an African in America, my discovery of nine partial differential equations is the culmination of a body of stories told and retold by mathematicians—the oldest story originating 3,700 years ago in the 4,100-mile-long Valley of the Nile in Africa.



Philip Emeagwali

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In this photo, I wrote on the board the actual equations used by the oil company Exxon (now Exxon Mobil) to simulate the flow of oil, water, and gas inside its petroleum reservoirs. I discovered a fundamental error in the equations used by oil companies, namely, four forces exist inside every petroleum reservoir; yet Exxon Mobil equation had summed only three forces. I created new mathematics by correctly summing all four forces, namely: pressure, viscosity, gravity, and inertia. After learning about my discovery, Mobil Research and Development Corporation invited me (in a letter dated March 19, 1990) to help the company in “reservoir simulation.” Certainly, for oil producing nations, it is an important mathematical discovery that helps produce more oil. [Philip Emeagwali, June 1996]

Geostrophic winds

The geostrophic wind equations are special cases of the full primitive equations used to forecast the weather. For example, the conservation of momentum equations for atmospheric circulation are:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} = 2\Omega(v \sin \phi - w \cos \phi) - \frac{1}{\rho} \frac{\partial P}{\partial x} + F_x$$

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} = -2\Omega u \sin \phi - \frac{1}{\rho} \frac{\partial P}{\partial y} + F_y$$

$$\frac{\partial w}{\partial t} + u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} = 2\Omega u \cos \phi - \frac{1}{\rho} \frac{\partial P}{\partial z} + F_z - g$$

The terms on the left hand side of the above system of equations represent the inertial forces. As was done in the derivation of Darcy's equation, ignoring the inertial terms in the above equations yields the geostrophic wind equations.

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I am an astronomer and a meteorologist who created new calculus for weather forecasting. This is an excerpt from an old memo I forwarded to a physicist explaining how to create new mathematics called partial differential equations from the wind velocities in the Earth's atmosphere. (Handwriting of Philip Emeagwali)