Zdeněk Stuchlík in the pursuit of beauty

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Zdeněk Stuchlík is a very successful, award-winning, university educator, adored by generations of students and peers for his role as a professor, lecturer, supervisor of doctoral theses and as a long-time proficient Dean of the Faculty of Philosophy and Science and the Director of the Institute of Physics at the Silesian University in Opava. He is widely recognized as the creator and leader of a distinctly original and productive circle of assistants and collaborators that he established in Opava. Working together with foreign visitors to Opava and colleagues abroad, Stuchlík and his Opavian team have spent the best part of three decades spearheading research into Einstein's General Relativity, most impressive in its scope and scale. Indeed, to the global community of physicists and astrophysicists, Zdeněk Stuchlík is simply a Czech scientist, a well-known and respected black hole theorist from Opava. And yes, many of them know that in addition Stuchlík sometimes goes awol, takes pictures and even shows them at exhibitions in respected art galleries and museums.

Because his photography is so fine and neatly sophisticated, people outside of the community of physicists, who attend these exhibitions, usually consider Stuchlík as somebody whose main occupation is solely photography. They assume that a Czech with his artistic talent must obviously belong to the world-esteemed mob of legendary Czech photographers, and are surprised to discover that he is not *also* — but *primarily* — a well renowned respected scientist.

Stuchlík is, of course, connected institutionally to Opava's world-famous *Institut tvůrčí fotografie* (The Institute of Creative Photography), where Jindřich Štreit, and other best known contemporary Czech photographers, work and teach. Stuchlík and Štreit are close friends; they were among a small team of visionary pioneers who created out of nothingness the Silesian University in Opava — at times of the great optimism and hope just after the Velvet Revolution. Today, their University is considered to be the best among all provincial universities in the Republic.

So many papers written and countless labours of love, all in the pursuit of exploring stunning beauties of reality — physical, mathematical and intellectual — all gorgeously presented in scholarly attempts to share these excitements with others!

During the years, I have witnessed Zdeněk's sure and brilliant acting in many of his distinguished social roles, but I see him, most of all, as my darling friend and a classy gentlemen, whom I trust in important matters of life and profession.

Happy birthday, Zdeněk.

1 STUCHLÍK THE ARTIST: SMOOTHER PEBBLES AND PRETTIER SHELLS.

An internal pre-requisite that compels those like Stuchlík to undertake so many different intellectual activities, has been metaphorically described in the profoundly modest words by Sir Isaac Newton:

> *– I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.*

Zdeněk has been exhibiting his photographs of smoother pebbles and prettier shells in Opava, Prague and other Czech cities, as well as in Wrocław, Warsaw, Vilnius, Riga, Trieste, Frankfurt and Oxford. His artistic creations have been already discussed in books, including one devoted solely to him. One of his quite often displayed photos, paints my silhouette portrait in a hotel window, against the background of the famous Copacabana beach in Rio de Janeiro. Thank you, Zdenku, for the *Macho in the window*.

Here in Opava, in January-February 2015, he had an exhibition *Neurčitý prostor* (Undefined space) together with Jerzy Olek, a top Polish artist-photographer and art theoretician. I wrote an introduction to its *Catalogue*, saying that the joint exhibition of photos taken by these friends of mine showed their utterly dissimilar ways of perceiving reality. Such striking differences cannot be explained through sole recourse to the stereotypical assumption that a scientist surveys the world by number, weight and measure, applying a cool eye to things and phenomena, whereas an artist sees reality in a way which is subjective, emotional and altogether irrational. There, at this exhibition, the stereotype was simply false. The unaware viewer would never have been able to guess which photos were taken by the "artist" and which ones by the "scientis".

Indeed, Zdeněk Stuchlík as an artist simply accepts the world along with its amazing complexity. He does not try to explain or even tentatively order reality. He does not strive to improve it. His photos represent faithful, unprocessed images of specific things. Some unyielding and eternal as seas, rocks or castles, others registered in a snapshot, and noticed exclusively by him. All Stuchlik's "things and voyages" constitute his own private catalogues of reality wherein he can accommodate portraits of his friends, views of Rio de Janeiro, as well as abstract light reflections in the fogs over the Gulf of Trieste. Stuchlík shows to us the beauty of the reality which is boundless, unique and inexplicable. He does his job humbly. He does not try to educate. Instead, he arranges his photographs in sequences whose deliberate lack of order imitates the puzzling and confusing randomness of the real world.

2 STUCHLÍK THE SCIENTIST: NAKED SINGULARITIES.

In its 19th December 2020 issue, *The Spectator* published a remarkable interview with Sir Roger Penrose by Dr Thomas Fink. In the interview, Penrose says that the Nobel Committee in Stockholm may have jumped the gun stating that they awarded him the Prize "for the discovery that black hole formation is a robust prediction of the general theory of relativity".

– I never proved black holes could be there, generically – smiles Penrose *– What I proved was that singularities had to be there.*

In the interview, Penrose carefully corrects this surprisingly common, and quite old, misconception that he has proved the existence of black holes, i.e. the existence of compact objects with the event horizon. No, he has not — and nobody ever has. Neither has he proven his own cosmic censor hypothesis, stating that singularities are always hidden inside event horizons, so that they cannot be visible from the outside. His original 1965 singularity theorem is quite remarkable, for it is based only on a few very general assumptions: it does not need even to assume Einstein's field equations! Indeed, a scrupulous and accurate student of the theorem would notice that all Roger Penrose needed for his proof was:

(1)   The existence of the 4D space-time $\mathbb{M}$ with a Lorentzian metric.

(2)   An existence in $\mathbb{M}$ of a compact, 2D *trapped surface* $\mathbb{T}$ such that both the ingoing and outgoing congruences of null geodesics emerging from $\mathbb{T}$ converge, in the sense of the negative expansion invariant, $\theta < 0$.

(3)   The gravity is attractive in the sense that along any congruence of null geodesics, $d\theta/d\mu < 0$, where μ is the affine parameter along the congruence.

(4)   There exists a non-compact Cauchy surface (this is roughly equivalent to say that the space-time has a trivial topology, for example it is not wrapped in space into a cylinder).

Note that usually instead of (3) one assumes the weak energy condition $R_{ab}X^aX^b > 0$, with X^a being a null vector and then one uses the Raychaudhuri equation, together with $\omega = 0$, in order to conclude that $d\theta/d\mu < 0$. Note also that $\omega = 0$ is not an extra assumption, as it must be $\omega = 0$ at the trapped surface $\mathbb{T}$ for the congruence in question (the congruence emerges from the surface $\mathbb{T}$ orthogonally) and thus, from the Newman Penrose equation for $d\omega/dit$ follows that $\omega = 0$ everywhere along this congruence.

I prefer to use the assumption $d\theta/d\mu < 0$ rather than $R_{ab}X^aX^b > 0$, as it avoids (seemingly only, but this is all right) the murky subject of the energy condition, the cosmological question of Λ, and so on.

One should be aware of the important point here: the Penrose theorem is far more general than most of the commentators, even those with a Ph.D. in physics, say (or know). The theorem works in *all Lorentzian*, and *not only strictly Einsteinian*, space-times in which gravity is attractive, which admit trapped surfaces, and which have a trivial topology (non-compact Cauchy surfaces). In such space-times singularities, *defined as null geodesic incompleteness*, are unavoidable. The Einstein field equations play no role in the proof when one assumes $d\theta/d\mu < 0$ instead of the usual $R_{ab}X^aX^b > 0$.

The space times and circumstances considered by Penrose are far more general than those strictly consistent with Einstein's theory. This was, perhaps still another reason for Penrose's delicate smile when he quoted Nobel Committee's wording of their explanation why they awarded him the Prize...

Nobody has proved that the Penrose cosmic censor hypothesis holds even in the standard Einstein's relativity. Could it therefore be so, that in our Universe the naked singularities are present? And if they are present, what would be their observable signatures? This is one of a few fundamental questions that have occupied Stuchlík's mind for a long time. Even

years before the Event Horizon Telescope time he and his collaborators in Opava were calculating images of naked singularities that would be in principle eventually possible to observe.

They found that the naked singularity images have features that are qualitatively (topologically) different than those that black holes may be consistent with. This is independent of all uncertainties with the emissivity properties of matter that surrounds these objects and is the source of photons emitted there, which are eventually detected by the EHT. Today the resolution is still too weak to dig out these features, but it will quickly, in a matter of a few years, improve.

I have only mentioned the naked singularities here, because they are so closely connected to this year's Nobel Prize in physics. But Stuchlík and colleagues are studying other possibilities as well: wormholes, strange stars, horizontless objects in alternative gravity theories... All these subjects belong to new, the brave and marvellous, future of physics. Very near future. Observations by EHT, Ligo-Virgo, Gravity and other astrophysical instruments alike, together with the purely theoretical insight coming from the directions that Zdeněk Stuchlík pioneered long ago and which are now the main subject of many, will soon open the flood gates. I hope to see successful and direct observational testing of the sweet dreams of XX and XXI century physics: *you better watch out — quantum gravity is coming to town!*

3   STUCHLÍK THE EDUCATOR.

Theoretical physics is not a profession like others, but almost an existential condition, a necessity of life. It requires a passionate commitment to conduct research, continuous and persistent self-education and joyful teaching of students at all university levels. The latter aspect is as important as the two first. Every theorist must be personally involved in education: preparing solid and interesting lectures, even when teaching is not an obligation arising from his university employment.

Dennis Sciama, John Wheeler, Richard Feynman and Lev Landau were probably the most charismatic and successful teachers of university physics in the XX century. I had the privilege to spent many years in Sciama's group, first in Oxford and then in Trieste, and two years in Wheeler's group in Austin, Texas. I have experienced first hand their tradition and attitude towards teaching physics, the quality of their courses and their unique style of shaping friendly and helpful master-student relations. To me, it is obvious that the way of teaching physics at Opava under Zdeněk, compares well with these best-in-class examples. Stuchlík has been able to create the school in which, at all stages of education, students are in the safe hands of their professors who offer each of them an individual plan to learn. Students enjoy academic freedom, but at the same time have well defined duties, and are involved not only in learning, but also, step by step, in participating in the Department's research and even in some administrative work. Stuchlík devotes a lot of extra- curricular time, giving himself personal tutorials to all students who need help.

And, of course, everyday we all go together for lunches, often for dinners, and sometimes to the *Slezské divadlo* (' 'it's an opera").

4   ZDENĚK, MY CZECH REFERENCE POINT.

To conclude, let me say something rather personal. I am a Pole who does not speak Czech, but who throughout his whole adult life, was fascinated by Czech culture, literature, way of life and customs. When I think of the personalities important in Czech culture and science who influenced me most of all, I remember, of course, Johannes Kepler, Jehuda Löw, Jan Hus, Franz Kafka, Christian Doppler, Alfons Mucha, Egon Erwin Kisch, Karel Čapek, Emil Zátopek, Bohumil Hrabal, Milan Kundera, Václav Havel, Marta Kubišová, Miloš Forman, Helena Vondráčkova, Jiří Bičák and Jara Cimrman... Then *Praga magica* where once I lived alone in a large, nice apartment at Malá Strana, through all seasons of the year changing one after the other. And, of course, Zdeněk Stuchlík who is my most important Czech reference point.

One day, Zdeněk and I enjoyed an evening in *U Krbu* , our favourite restaurant in Opava, in the company of a few colleagues, mostly from the University, and a few students. We all were a bit drunk. Not much, of course, just a tiny bit. – *Zdenku* – I asked – *tell me please, taking into account just everything you could think of: which country in Europe would you consider to be the best to live a happy life?*

– *The Czech Republic.* – he replied immediately

– *Really? And why not Switzerland?* – I expressed my surprise.

– *Because our mountains are smaller.*

Zdeněk Stuchlík, *Macho in the Window* (Rio de Janeiro, 2003)

This book is especially dedicated to Professor Zdeněk Stuchlík and his work as a celebration of his 70th birthday.