MSc Seminar, David Szasz-Schagrin

Names of students *

László Gyulai, Zsolt Györgypál

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Black holes are parts of the space where the gravitational force is so strong that no particles or EM-waves can escape.
2. Black holes are characterized by 3 parameters: the mass, the charge and the angular momentum.
3. Black holes (BH) with the same of these 3 parameters are considered indistinguishable, and the internal structure (the way they were formed) doesn't matter.
4. The surface of a BH can only increase, so we can build up an analogy between the thermodynamical entropy and the BH's surface area.
5. After a lengthy derivation it can be shown that if the entropy is a linear function of the surface are, then we get no contradictions, and we can calculate the constant factor in the linear function.
6. At the end of his talk, the lecturer thanked for our attention :)

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Borsi Márton, Tamás Gábor

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1. The large enough text size and the simple but elegant style of the slides made it comfortable to follow the talk.
2. The speaker often tried to avoid eye-contact with the audience (looked at the slides instead).
3. We can make an analogy between entropy and black hole area.
4. It is possible to give a formal definition of black hole entropy using the black hole analog of the first law of thermodynamics.
5. The only parameters of black hole entropy are mass, charge and angular momentum.
6. The black hole entropy grasps the inaccessibility of the internal structure.
7. Black hole entropy can be chosen as a linear function of the surface.
8. The generalised second law tells that the sum of the black hole entropy and the common entropy can only increase.

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Vízkeleti Áron

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1 He started with a quick overview of the properties of black holes, like the no hair theorem: a black hole may not have properties besides (Q-charge, L-angular momentum, mi – internal mass)
2 Then the talker drew an analogy between statistical physics and general relativity, in the context of blackholes.
3 He followed up by showing the similarity between the classical thermodynamical systems and black holes.
4 He defined an entropy like quantity for black holes, as well as the black-hole variant of the second and first law (of thermodynamics).
5 There was several equations on the slides which were not explained. I think it would have been somewhat better to not show them at all. Besides these parts, the talk was nicely structured.
6 I think that the topic is interesting to me because I do not have Cosmology and cosmology-like subjects.

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Sári Péter, Horváth Anna, Balázs Péter

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1. The talk was about describing black holes using thermodynamics.
2. The only observable quantities of such objects are their mass, charge and spin.
3. Kerr black holes are black holes with non-zero spin and charge.
4. Starting out from the 1st law of thermodynamics, we derive an entropy like quantity, which we call black hole entropy.
5. This quantity is proportional to the surface of the object.
6. Launching particles into a black hole means a loss of information, thus an increase in black hole entropy.
7. We can't be sure if the thermodinamic entropy increases during this, so we use a generalized form of the 2nd law, where the sum of the two entropies increases.

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Szombathy Dominik

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. David chose a '70's article, in which he described Black holes and their entropy.
2. The structure of talk was logical, he started the talk with explaining the basic terminology which were used throughout the talk.
3. After this, we got to know how to classify black holes by M,L,Q .
4. Here I want to point out, that altough it was not a slow paced talk, which is in itself not a problem, it was a bit quiet :(
5. Classification was followed by energy formulation and thermodynamic law connections to the black hole's entropy.
6. These connections were illustrated by P,V,T <-> M,Q,L analogy
7. At the it turns out thet the paper result was a good approximation, even for todays results.

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Reka Szilvasi

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

The presentation was about the beautiful analogy between the description of astrophysical (relativistic) black holes and thermodynamics (statistical physics - quantum mechanics). The presented black hole entropy formula shows this analogy quite nicely connecting the gravitational constant (G) with thermodynamical quantities. The speaker introduced the basic properties of black holes: for exmaple the types of black holes (e.g. Kerr black holes: rotating and charged), and emphasized that by their internal structure two black holes cannot be distinguished, only the external observables (mass, angular momentum, charge) can be used to differentiate between black holes (no-hair theorem). The first sign of analogy between area and entropy is shown in Hawking's general theorem: black holes increase their horizon undergoing any process but the surface of the black hole cannot decrease in any process - entropy always increases and black hole area always increases. Introducing the formal definition of black hole entropy one can find the analogy of the first law of thermodynamics for the irreducible mass! In the end, after explaining briefly the derivation of the mathematical formula for black hole entropy, the possibility of a generalized second law was mentioned: black hole entropy + common thermondynamic entropy in the black hole exterior never decreases.

Your choice of topic is really much appreciated.

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Zsombor Szilagyi, Bendeguz Sulyok

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1: Black Holes are special regions of space time, that can be sufficiently described by M, Q and L.
2: Two BHs sharing the same M, Q and L cannot be differentiated.
3: A Kerr-BH is a rotating BH with no charge (Q=0, L=/=0).
4: The total mass energy is parametrized by the irreducible energy M_ir, that cannot be extracted.
5: M_ir can never be reduced by the capture of a particle; the horizon can never decrease in size; reversible processes do not change M_ir.
6: Hawking theorized that the surface can never decrease, this brings attention to the analogy between surfacial area and entropy.
7: dM composed of an entropy term and a work term.
8: Change in information can be understood as negative change in entropy.
9: To get an idea of the BH entropy, let's assume a relation S_BH = f(alpha) where f is a monotonically increasing function of alpha, the BH surface.
10: A choice of linear relation yields no cotradiction: f = gamma * alpha. The function f can be expressed with the following experiment: a particle (formally one bit of information) is thrown into a BH, this yields some minimal surface increase and f can be expressed.
11: A generalized form of the second law of thermodynamics was produced which is consistent with both quantum mechanics and special relativity.

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Pályi András, Földvári Dominic

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1. The talk was about black holes and how they can be associated with an emtropy. The main result is a formaul for the black hole entropy containing only the surface as a variant.
2. A black hole can be prametrized by mass(M), charge(Q) and angular momentum(L) which appears in the formula of the so-called irreducible mass. This part of the energy cannot be extracted at all.
3. Couple of theorems state equally that increase in the horizon of a black hole happens under any processs. More strictly the surface cannot decrease.
4. By these statements we can define an analogy with the well known clasical entropy assuming the following correspondencies:
- the first law of thermodynamics can be defined for a black hole using Q, L and the surface as variables, while the energy is associated with M
- information theory laws dictate that entropy change measures the inaccesability of internal configurations, which is defined at the creation of the black hole and gets washed out as time evolves.
5. The exprassion of black hole entropy can be deduced from the fact that it has to be proportional to the surface of black hole. Now the proportionality can be calculated using dimensional analysis.

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Zoltán Varga

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1) we have heard about the Black Holes' entropy and a short introduction about them. I was wondering that only 3 parameters are enough to define the state of the BH (but we have no information about the internal structure itself).
2) The fact that the statistical physics connects field of QM and General relativity is also fascinating. After the introduction part, we've seen that we can make general and basic theory that connects the 3 parameters of the BH with area of its.
3) With the information theory we can derive the Shannon entropy which helps us to get info about the entropy of BH. It measures the inaccessibility of the internal processes in the BH.
4) Due to the formal baseline, through a thought experiment (thrown particle into the BH, calculate the change of the area), we can construct a prediction of S of the BH.
5) After we get the S, we can construct the basics of informational thermodynamics of the Black Hole, which contains a generalized second law with the common entropy.