Card game for 3 to 33 players aged 9 to 90 about astroparticle physics

**Introduction**

Astoparticle physics combines astrophysics, high energy physics and particle physics. In this game you will learn something about the fascinating science.

**Preparation**

Print the pages with the cards, fold it so that a black and a white side make the front and back of one card and cut along the horizontal lines.

**Game manual**

The cards are riffled and equally distributed among the players. (It does not matter whether one player has more cards than the others. If there are 33 players, everybody gets one card).

On each card is a question on one side.

On each card (except for the first) is an anwer to another question on the other side.

So the first player (the one without the answer) reads her/ his question aloud.

The other players turn their cards and look whether they have got the answer.

The one who has got the answer reads the answer. Then she/ he turns the card and reads the new question ...

**Have fun!**

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| How did humans get information about our universe in the past? |  |
| What is the disadvantage of light here? | light from the stars |
| So particles that penetrate would be nice. What is matter made of? | it can be absorbed  |
| What are atoms made of? | atoms |
| Protons and electrons also hit the atmosphere. Where and how can everybody observe that? | protons and neutrons in the nucleus, electrons in the atomic shell |
| Which characteristic of the earth leads to the fact, that polar lights are not straight lines? | polar light |
| Therefore one cannot find out, where the protons came from, but one can measure their energy: up to 1020 eV. What does the number 1020 mean? | the earth` magnetic field deviates charged particles |
| What does the unit eV mean? | a 10 with 20 zeros |
| The worlds biggest accelerator at CERN reaches very high energies, 7 TeV per particle – is this more or less than 1020 eV? | electron volt: that is the kinetic energy an electron gets, when it passes a voltage of 1V |
| Neutrino in a bar | Terra is 1012, so it´s more than 10 Million times smaller |
| What qualifies neutrinos as messengers? | no charge |
| What is the difficulty when detecting neutrinos? | they show the direction where they came from |
| How can they be measured anyway?  | they interact only weakly and mostly pass through matter |
| True or false? Neutrinos go into a charged muon, that moves faster than light in water or ice. | big detector => Km3NET in the mediteranean sea and IceCube in the Antartica |
| Why? | true |
| The moving muon makes a light cone in water or ice, which can be detected. The tracks show origins of the particles. Where do they originate? | maximum possible speed is $3∙10^{8}\frac{m}{s}$ , but this is light in vaccum, whereas light slows down in a medium |
| Why are they called active? | candidates are active galactic nuclei |
| Pictionary: Black Hole | they send a bright jet of light and particles in the universe |
| What is a black hole? | Black Hole – that is in the center |
| First image of Black Hole captured?  | a region with very strong gravitation |
| Black Hole is bounded by? | 10th April 2019 using Event Horizon Telescope in the center of M87 galaxy |
| What is Gravitational Collapse? | an event horizon, beyond that no light can escape the region because of gravity |
| What is the possible end state of a massive star? | death of a star |
| A light-year is the distance light travels in one Earth year. What is the equivalent distance of 1 light-year in km? | Neutron Star |
| 1 Parsec is a length: When the apparent shift of a star during half a year in relation to active galactic nuclei is one arcsecond – how far away is the star? | 9.46×1012 km |
| Pantomime: Big Bang | 3.26 light years  |
| How do we know our universe expands? | Big Bang – the assumed beginning of the universe |
| What might gravitational waves teach us about the universe? | there is background radiation of low temperature 2.7 K left: from the high temperature the universe cooled down due to expansion |
| Why are gravitational waves so hard to detect? | they could soon give us a measure of the expansion of the universe |
| What is Dark Energy? Why do we know it exists? | they only stretch spacetime a tiny amount |
| What is Dark Matter? Why do we know it exists? | anti-graviational force – the expansion of our universe is accelerated  |
| Candidates are WIMPS “weakly interacting particles”. What have all astroparticles in common? | it has got strong gravitational forces which we can measure |
|  | they are all messengers from the universe |