

# FUNDAMENTAL PHYSICS IN THE COSMOS.

The early, the large and the dark universe

**DESY Theory Workshop**  
**26 - 29 September 2017**  
**Hamburg, Germany**

## PLENARY Talks

A. Arvanitaki (Perimeter)  
T. Baker (Oxford)  
M. Baryakhtar (Perimeter)  
B. Batell (Pittsburgh)  
F. Calore (Annecy)

C. Caprini (APC Paris)  
J. Chluba (Manchester)  
N. Christensen (Carleton)  
P. Creminelli (ICTP Trieste)  
R. Flauger (UC San Diego)

S. Galli (IAP Paris)  
A. Hebecker (Heidelberg)  
L. Hui (Columbia)  
J. Garcia-Bellido (Madrid)  
D. Kaplan (U. Johns Hopkins)

I. Mandel (Birmingham)  
W. Percival (Portsmouth)  
P. Serpico (Annecy)  
A. Ringwald (DESY)  
A. Schmidt-May (LMU Munich)

## DESY Heinrich-Hertz-Lecture on Physics

A. Guth (MIT)

**27 September 2017**

## PARALLEL SESSIONS

Contributions by young researchers are especially encouraged.

Deadline for abstract submission: 21 July 2017

- **Cosmology & Astroparticle Physics:** V. Domcke (APC Paris & DESY), B. Garbrecht (TU Munich)
- **Particle Phenomenology:** S. Schumann (U. Göttingen), J. Tattersall (RWTH Aachen)
- **Strings & Mathematical Physics:** V. Forini (HU Berlin), I. Garcia Etxebarria (MPI Munich)

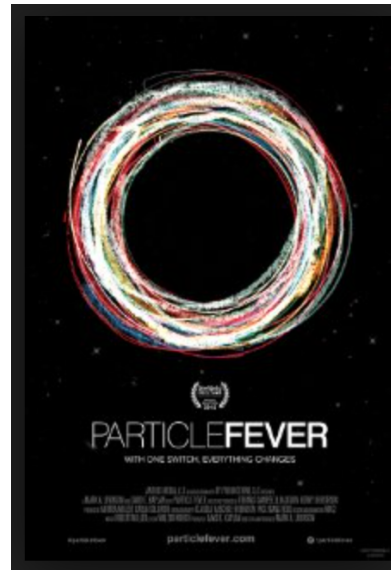
### ORGANIZING COMMITTEE:

B. Allen, L. Amendola, M. Garny, A. Ibarra,  
J. Jaeckel, J. Lesgourgues (Chair),  
N. Libeskind, D. Schwarz, T. Schwetz,  
G. Servant, J. Weller, A. Westphal

**<http://th-workshop2017.desy.de>**

**This evening after the plenary session**

**6:00 -6:30 pm: Entertainment with "Particle Fever Short"**



**6:30 pm: Reception**

## **Speakers:**

**Please upload your slides on Indico!**

**(if you don't have an account give pdf file on USB  
stick to your convener**

## **Parallel sessions in 4 locations:**

Bldg. 1, Seminar room 1

Bldg. 1b, Seminar Room 4a

Bldg. 1b, Seminar Room 4b

Bldg. 2a, Seminar Room 2



# On Wednesday evening: Hertz lecture followed by conference dinner

## HERTZ LECTURE.

DESY Lecture on Physics 2017

IS IT POSSIBLE TO CREATE A UNIVERSE IN ' QUANTUM TUNNELING

Edward FARHI\*

## Inflationary Cosmology: Is Our Universe Part of a Multiverse?

Prof. Dr. Alan Guth  
(Massachusetts Institute of Technology)

27 September 2017

18:00 h, DESY Auditorium

Notkestraße 85 | 22607 Hamburg | Germany

<http://www.desy.de/hertz>

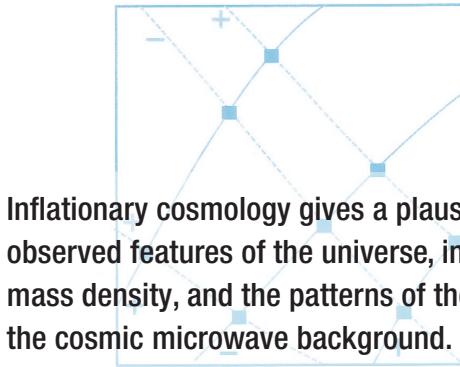
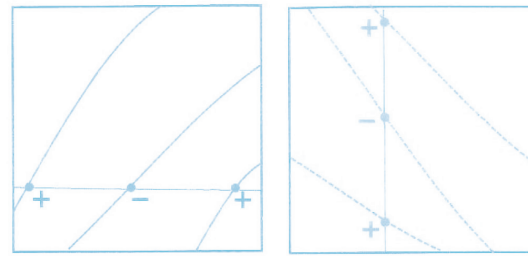


FIG. 1. Top left and right: Potential energy curves for inflationary cosmology. The left diagram shows a potential energy curve with a minimum and a maximum, with a trajectory starting from the minimum and moving towards the maximum. The right diagram shows a potential energy curve with a minimum and a maximum, with a trajectory starting from the minimum and moving towards the maximum.

We calculated the same quantities using a GOE

$$N_{\text{saddle}} = 2 \left( 1 + \sqrt{2} \right) N_{\text{min}} \approx 4.82 N_{\text{min}}$$

Notice that to derive (12) we used an average symmetry of  $U \rightarrow$  fore, (12) will not be valid for each realization of in Figure 2.

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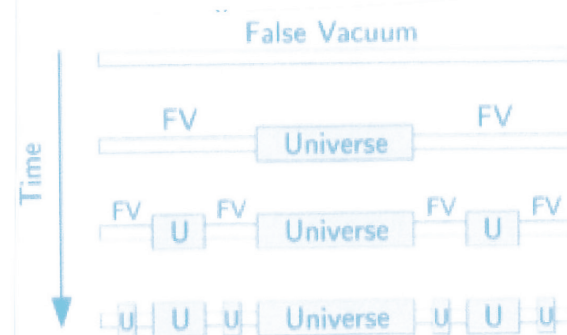


Fig. 3. A schematic illustration of eternal inflation.

PHYSICAL REVIEW D

VOLUME 23, NUMBER 2

15 JANUARY 1981

### Inflationary universe: A possible solution to the horizon and flatness problems

Alan H. Guth\*

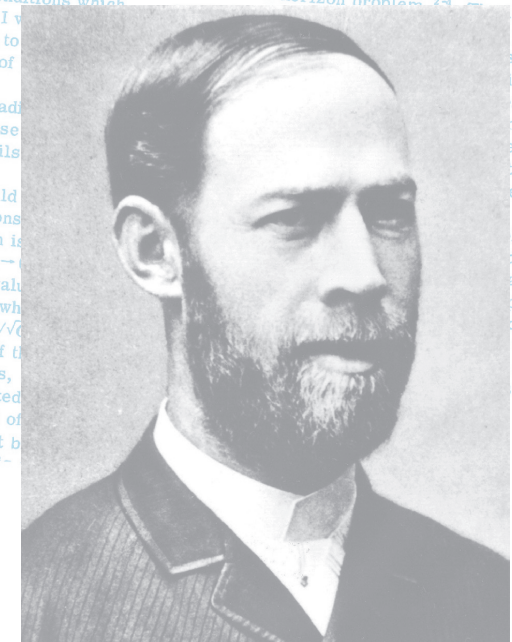
Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305  
(Received 11 August 1980)

The standard model of hot big-bang cosmology requires initial conditions which are problematic in two ways: (1) The early universe is assumed to be highly homogeneous, in spite of the fact that separated regions were causally disconnected (horizon problem); and (2) the initial value of the Hubble constant must be fine tuned to extraordinary accuracy to produce a universe as flat (i.e., near critical mass density) as the one we see today (flatness problem). These problems would disappear if, in its early history, the universe supercooled to temperatures 28 or more orders of magnitude below the critical temperature for some phase transition. A huge expansion factor would then result from a period of exponential growth, and the entropy of the universe would be multiplied by a huge factor when the latent heat is released. Such a scenario is completely natural in the context of grand unified models of elementary particle interactions. In such models, the supercooling is also relevant to the problem of monopole suppression. Unfortunately, the scenario seems to lead to some unacceptable consequences, so modifications must be sought.

#### I. INTRODUCTION: THE HORIZON AND FLATNESS PROBLEMS

The standard model of hot big-bang cosmology relies on the assumption of initial conditions which are very puzzling in two ways which I will discuss. The first is the horizon problem, which is the fact that the universe is so uniform in temperature and density that it is difficult to understand how it could have been so uniform if it had been created in a single event. The second is the flatness problem, which is the fact that the universe is so flat that it is difficult to understand how it could have been so flat if it had been created in a single event.

completely described. Now I can explain the puzzles. The first is the well-known horizon problem. The first is the initial uniformity of the universe. Yet it contains regions which are causally disconnected. Each other options are ruled out in the forces which are capable of solving the problem. This is the horizon problem. The second is the flatness problem. The universe is so flat that it is difficult to understand how it could have been so flat if it had been created in a single event.



Heinrich Hertz  
1857 Hamburg-Karlsruhe-Bonn 1894

MIT-CTP-2948, astro-ph/0002156

### Inflation and Eternal Inflation

Alan H. Guth

Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA  
and  
Isaac Newton Institute for Mathematical Sciences, Clarkson Road, Cambridge CB3 0EH, UK



#### Abstract

The basic workings of inflationary cosmology are described. The early universe is assumed to be highly homogeneous, in spite of the fact that separated regions were causally disconnected (horizon problem); and (2) the initial value of the Hubble constant must be fine tuned to extraordinary accuracy to produce a universe as flat (i.e., near critical mass density) as the one we see today (flatness problem). These problems would disappear if, in its early history, the universe supercooled to temperatures 28 or more orders of magnitude below the critical temperature for some phase transition. A huge expansion factor would then result from a period of exponential growth, and the entropy of the universe would be multiplied by a huge factor when the latent heat is released. Such a scenario is completely natural in the context of grand unified models of elementary particle interactions. In such models, the supercooling is also relevant to the problem of monopole suppression. Unfortunately, the scenario seems to lead to some unacceptable consequences, so modifications must be sought.

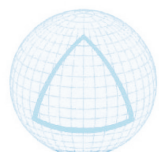
Inflationary Cosmology: Exploring the Universe from the Smallest to the Largest Scales  
Alan H. Guth\* and David I. Kaiser†  
Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA  
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Accelerators | Photon Science | Particle Physics

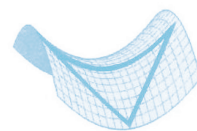
Deutsches Elektronen-Synchrotron

A Research Centre of the Helmholtz Association

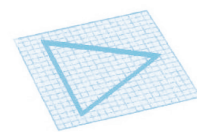
Understanding the behavior of the universe at large depends critically on understanding the behavior of the universe at small scales. Inflationary cosmology makes such a connection between the large and small scales. The agreement between the latest observations and the predictions of inflationary cosmology is a key notion in the ultimate implications for the future of the universe.



Closed Geometry



Open Geometry



Flat Geometry



On Wednesday evening: Hertz lecture followed by conference dinner

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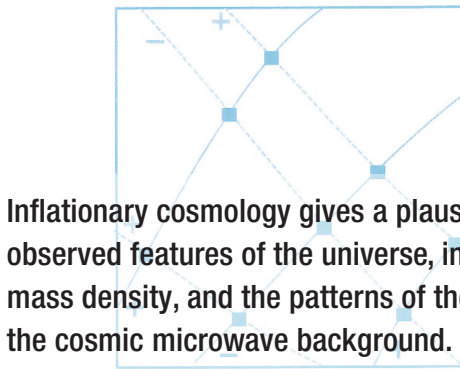
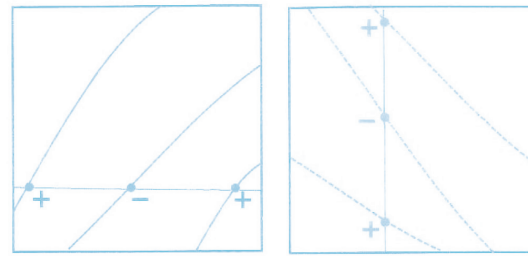


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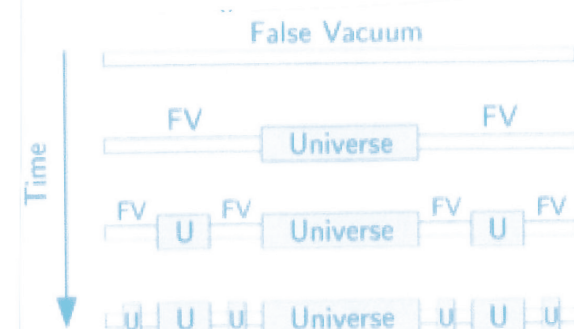


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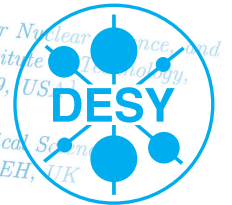


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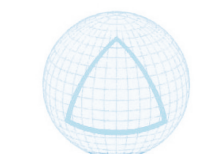
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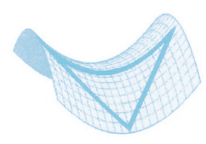
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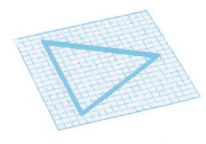
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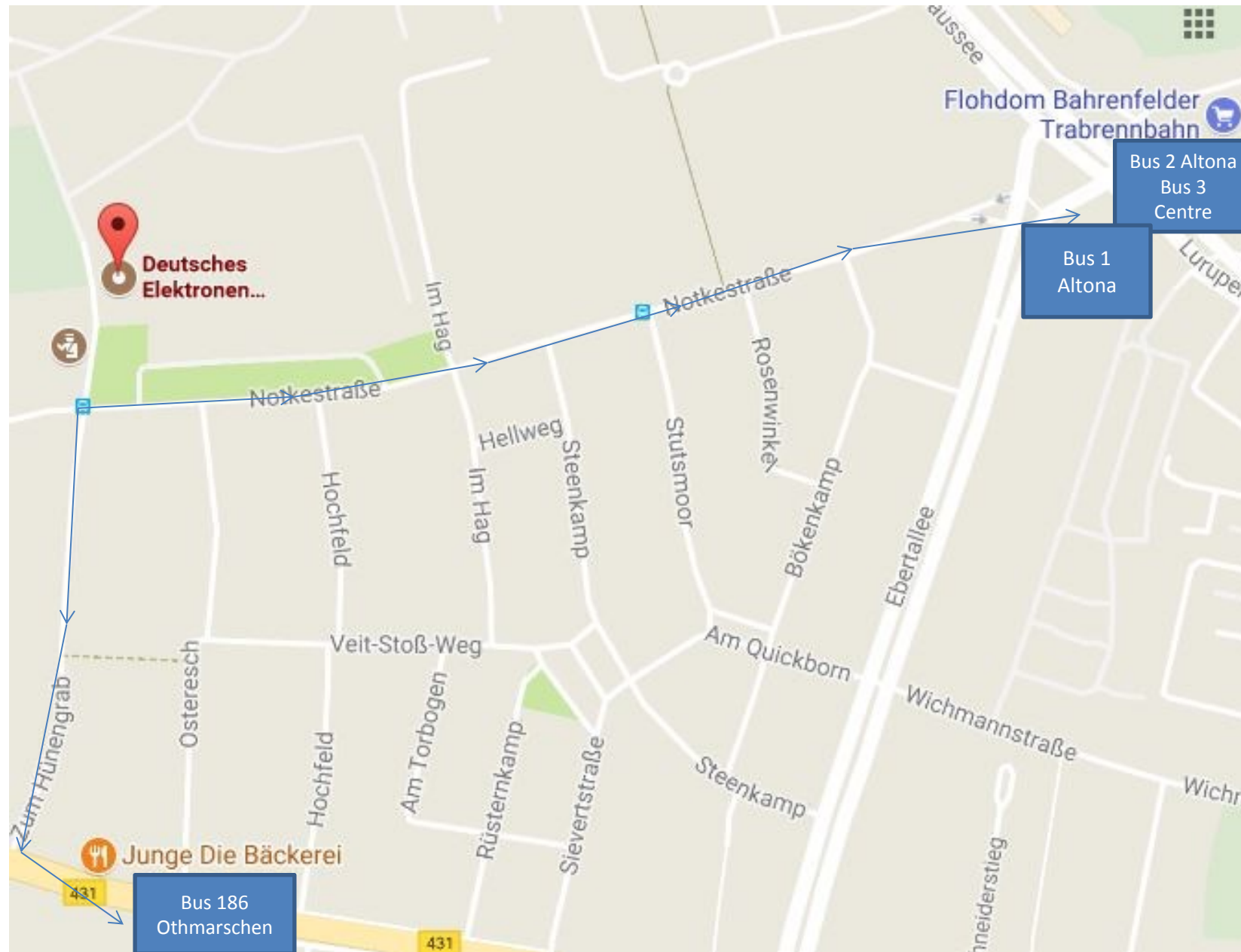


Flat Geometry

**Group Photo**  
**@ 11:00 on thursday Sept. 28th**

**Bus stop DESY/Zum Hühnengrab (bus Nr. 1, direction Othmarschen/Altona) is moved until 4 October due to extensive roadworks.**

**This affects only the public transport **\*\*FROM\*\*** DESY to Othmarschen or Altona—the way **\*\*TO\*\*** DESY from Othmarschen or Altona is not affected.**





# Restaurants near DESY (for more info see printed lists near registration desk)

Name	Location	Cuisine	Information
<b>Restaurants near DESY:</b>			
Die Bäckerei	Osdorfer Landstr. 4	Italian	040-33 31 09 14
Restaurant Landhaus Flottbek	Baron-Voght-Str. 179	International	<a href="http://www.landhaus-flottbek.de">http://www.landhaus-flottbek.de</a>
Restaurant Champus	Beselerstr. 35	German	040-89 06 53 50
Restaurant Mahlzeit	Albert-Einstein-Ring 8	Asian	040-80 03 03 08
Blockhouse	Waitzstr. 1	Steakhouse	<a href="http://www.block-house.de">http://www.block-house.de</a>
Ristorante Panetteria	Osdorfer Landstr. 4	Italian	040-89 06 48 02
L'Incontro, il Bistro	Ebertallee 232	Italian	<a href="http://www.lincontro.info/bahrenfeld/index.php">http://www.lincontro.info/bahrenfeld/index.php</a>
Restaurant Quellental	Quellental 36 Near Klein Flottbek station	Mediterranean	<a href="http://www.quellental-restaurant.de">www.quellental-restaurant.de</a>
Don Quichotte	Osdorfer Landstr. 162	International	<a href="http://www.osdorfermuehle.de">www.osdorfermuehle.de</a>
Lühmann's Teestube	Blankeneser Landstr. 29	English, Vegetarian	<a href="http://www.luehmanns-teestube.de">www.luehmanns-teestube.de</a>
Restaurant „Le Jardin“ im Hotel Merkure Am Volkspark	Albert-Einstein-Ring 2	Regional	040-89 95 20

# WIFI

Network name: TH-Workshop-2017

Password: aMieRoVoo3fa

see printed copies  
near registration desk



DESY THEORY WORKSHOP  
26 - 29 September 2017

**Fundamental physics in the cosmos:  
The early, the large and the dark Universe**

DESY Hamburg, Germany



## Information

<b>WLAN</b>	Conference WLAN Network name: <b>TH-Workshop-2017</b> Password: aMieRoVoo3fa
<b>Hostel</b>	Check In Time: 2:00 pm Check Out Time: 10:30 am
<b>Coffee breaks</b>	<u>Plenary sessions:</u> bldg. 5, foyer of the auditorium <u>Parallel sessions:</u> Bldg. 1, foyer in front of seminar room 1 + bldg. 1b, SR 3a + foyer in front of SR 4a/b + bldg. 2a, foyer in front of SR 2
<b>Cash machine</b>	A cash machine is located in the foyer of canteen-building 9
<b>Taxi to the airport</b>	Please contact the registration desk
<b>Public transport to airport</b>	Please note that, due to construction works, the bus station DESY/Zum Hühnengrab (direction Altona) has been moved. Take bus 1 from bus stop Bahrenfeld, Trabrennbahn to S-Othmarschen/Altona, change at S-Othmarschen to S-Bahn S1 to airport (first three wagons). Alternatively you can take bus 186, direction Othmarschen, from Osdorfer Landstraße vis-à-vis bakery "Junge". You only need to buy one ticket (3,10 €, the bus driver sells tickets).
<b>Supermarkets</b>	<b>Lidl</b> , from main entrance – Notkestraße – turn right and follow the street (~800 m). It will be clearly visible on the left of the street at the next junction. <b>Penny</b> , from main entrance – Notkestraße – walk straight down the street "Zum Hühnengrab". On the right hand side at the end of the street.



**If you have any questions do not hesitate to ask**

**Secretaries: Cristina Guerrero, Inna Henning and**



**Chair: Julien Lesgourgues**



**Local organisers: Géraldine Servant & Alexander Westphal**

