Integrable Cosmological Models with Liouville Fields

Alexander A. Andrianov[1,4] Chen Lan[2] Oleg O. Novikov[1]
Yi-Fan Wang[3]

[1] Saint-Petersburg State University, St. Petersburg 198504, Russia

[2] ELI-ALPS, ELI-Hu NKft, Dugonics tér 13, Szeged 6720, Hungary

[3] Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

[4] Institut de Ciències del Cosmos (ICCUB), Universitat de Barcelona, Spain

December 8, 2017

Outline

Introduction

Introduction

-

The Friedmann–Lemaître model

- Flat Robertson–Walker metric $\mathrm{d}s^2 = -N^2(t)\,\mathrm{d}t^2 + \varkappa^{-1}\mathrm{e}^{2\alpha(t)}\,\mathrm{d}\Omega_3^2$, where $\varkappa := 8\pi G$, $\mathrm{d}\Omega_3^2$ dimensionless spacial metric.
- Homogeneous real Klein–Gordon field with potential $V\mathrm{e}^{\lambda\phi}$ (Liouville), where $\lambda, V \in \mathbb{R}$, and kinetic term with sign $\ell = \pm 1$ (quintessence / phantom model).
- Total action $\mathcal{S} := S_{\mathsf{EH}} + S_{\mathsf{GHY}} + S_{\mathsf{L}} = \int \mathrm{d}\Omega_3^2 \int \mathrm{d}t\, L$, in which the effective Lagrangian reads

$$L := \varkappa^{3/2} N \mathrm{e}^{3\alpha}\left(-\frac{3}{\varkappa}\frac{\dot{\alpha}^2}{N^2} + \ell\,\frac{\dot{\phi}^2}{2N^2} - V\mathrm{e}^{\lambda\phi}\right), \tag{1}$$

in which dot means $\mathrm{d}/\mathrm{d}t$ and $\ell = \pm 1$.

Decoupling the variables

Via *rescaled* special orthogonal transformation

- Setting $\overline{N} := N \mathrm{e}^{-3\alpha}$, eq. (1) transforms to

$$L = \varkappa^{3/2}\overline{N}\left(-\frac{3}{\varkappa}\frac{\dot{\alpha}^2}{\overline{N}^2} + \ell\,\frac{\dot{\phi}^2}{2\overline{N}^2} - V\mathrm{e}^{\lambda\phi+6\alpha}\right) \qquad (2)$$

- Defining $\Delta := \lambda^2 - 6\ell\varkappa$, $\mathfrak{s} := \operatorname{sgn}\Delta$ and $g := \mathfrak{s}\sqrt{|\Delta|} \equiv \mathfrak{s}\sqrt{\mathfrak{s}\Delta}$, the *rescaled* special orthogonal transformation

$$\begin{pmatrix}\alpha\\ \phi\end{pmatrix} = \frac{\mathfrak{s}}{g}\begin{pmatrix}\lambda & -\ell\kappa\\ -6 & \lambda\end{pmatrix}\begin{pmatrix}\mathfrak{s}_\beta\beta\\ \mathfrak{s}_\chi\chi\end{pmatrix} \qquad \text{where } \mathfrak{s}_\beta, \mathfrak{s}_\chi = \pm 1 \qquad (3)$$

gives the decoupled Lagrangian

$$L = \varkappa^{3/2}\overline{N}\left(-\mathfrak{s}\frac{3}{\varkappa}\frac{\dot{\beta}^2}{\overline{N}^2} + \ell\,\mathfrak{s}\,\frac{\dot{\chi}^2}{2\overline{N}^2} - V\mathrm{e}^{\mathfrak{s}_\chi g\chi}\right). \qquad (4)$$

- The Euler–Lagrange equations w.r.t. $\overline{N}$, β and χ will be called the trsfed. 1st, 2nd Friedmann eqs. and the Klein–Gordon eq., respectively.

Generalisation of the decoupling technique
233

- Beyond isotropy
  - Bianchi Type-I
- Beyond one Liouville field
  - Two exponential potentials: $V_1 = V_2$ and special λ_i
  - Multiple Liouville fields: mixing kinetic terms[1]
- Beyond classic matter
  - Non-Hermitian, PT-symmetric Liouville fields[2]

[1] Alexander A. Andrianov, Oleg O. Novikov, and Chen Lan. In: *Theoretical and Mathematical Physics* 184.3 (2015), pp. 1224–1233.

[2] Alexander A. Andrianov et al. In: *International Journal of Modern Physics D* 19.01 (2010), pp. 97–111, Alexander A. Andrianov, Chen Lan, and Oleg O. Novikov. In: *Springer Proceedings in Physics*. Springer International Publishing, 2016, pp. 29–44.

Implicitised integration

$p_\beta \neq 0$

- Since β is cyclic in eq. (4), the trsfed. 2nd Friedmann eq. can be integrated[3]

$$\text{const.} \equiv p_\beta := \frac{\partial L}{\partial \dot{\beta}} = -6\jmath \varkappa^{1/2} \frac{\dot{\beta}}{\overline{N}} \equiv -6\jmath\jmath_\beta \frac{\varkappa^{1/2}}{g} \frac{\lambda\dot{\alpha} + \ell\varkappa\dot{\phi}}{\overline{N}}. \tag{5}$$

- For $p_\beta \neq 0$, fixing the *implicitising gauge* $\overline{N} = -6\jmath\sqrt{\varkappa}\dot{\beta}/p_\beta$, the trsfed. 1st Friedmann equation can be integrated

$$\mathrm{e}^{\jmath_\chi g\chi} = \frac{p_\beta^2}{12\varkappa^2|V|} S^2\left(\jmath_\beta\sqrt{\frac{3}{2\varkappa}}\, g\beta + C\right), \tag{6}$$

in which $\upsilon := \operatorname{sgn} V$, (sgn, sgn) means $(\ell, \jmath\upsilon)$, and

$$\begin{aligned} {}_{(+,+)}S(\gamma) &:= \operatorname{sech}(\gamma), & {}_{(+,-)}S(\gamma) &:= \operatorname{csch}(\gamma), \\ {}_{(-,+)}S(\gamma) &:= \sec(\gamma), & {}_{(-,-)}S(\gamma) &:= \mathrm{i}\csc(\gamma). \end{aligned} \tag{7}$$

[3] Chen Lan. PhD thesis. Saint Petersburg State University, 2016, Alexander A. Andrianov, Oleg O. Novikov, and Chen Lan. In: *Theoretical and Mathematical Physics* 184.3 (2015), pp. 1224–1233.

Integration

Discussions

- The integrals are consistent with the trsfed. Klein–Gordon equation.
- The integral for $(+,+)$
  - has two asymptotes
- The implicitised integral for $(+,-)$
  - contains two distinct solutions
  - has three asymptotes
- The implicitised integral for $(-,+)$
  - is β-even for $C=0$
  - contains infinite distinct solutions
  - has infinite asymptotes, which are pairwise parallel
- The integral for $(-,-)$
  - is not real
- The implicitised integral enables one to compare trajectories with wave functions, see below.

Implicitised integration

$p_\beta = 0$

- For $p_\beta = 0$, one has $\beta \equiv \beta_0$ or $\phi - \phi_0 = -\ell\lambda\alpha/\kappa$, which is the familiar power-law special solution[4].
- Further integrating the first Friedmann equation demands $(+,-)$ or $(-,+)$ to guarantee $\overline{N} > 0$, and the result is automatically consistent with the trsfed. Klein–Gordon equation.
- Fixing $\overline{N} = (2\varkappa^2|V|)^{-1/2}$ yields

$$\mathrm{e}^{g s_\chi \chi} = \left(\frac{2\kappa}{g(t-t_0)}\right)^2. \tag{8}$$

[4] Mariusz P. Dąbrowski, Claus Kiefer, and Barbara Sandhöfer. In: *Physical Review D* 74.4 (2006).

Dirac quantisation
233

- The primary Hamiltonian and the Hamiltonian constraint reads

$$H^{\mathsf{p}} = \overline{N} H_\perp + p_{\overline{N}} v^{\overline{N}}, \tag{9}$$

$$H_\perp = -\jmath \frac{p_\beta^2}{12\varkappa^{1/2}} + \ell \jmath \frac{p_\chi^2}{2\varkappa^{3/2}} + \varkappa^{3/2} V \mathbb{e}^{g\jmath_\chi \chi}. \tag{10}$$

- Applying the Dirac quantisation rules with Laplace–Beltrami opeator, one gets the mss. Wheeler–DeWitt eq. with (β, χ)

$$0 = \widehat{H}_\perp \Psi(\beta, \chi) := \left(\jmath \frac{\hbar^2}{12\varkappa^{1/2}} \partial_\beta^2 - \ell \jmath \frac{\hbar^2}{2\varkappa^{3/2}} \partial_\chi^2 + \varkappa^{3/2} V \mathbb{e}^{g\jmath_\chi \chi} \right) \Psi. \tag{11}$$

- Equation (11) is KG-like, hyperbolic for $\ell = +1$ and *elliptic* for $\ell = -1$.

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Separation of the variables and mode functions
233

- Writing $\Psi(\beta,\chi) = \varphi(\beta)\psi(\chi)$, eq. (11) can be separated into

$$\partial_\beta^2 \varphi(\beta) = k_\beta^2 \varphi(\beta); \tag{12}$$

$$\mathbb{D}\psi(\chi) = k_\beta^2 \psi(\chi), \qquad \mathbb{D} := -\ell \frac{6}{\varkappa}\partial_\chi^2 + \jmath\upsilon \frac{12\varkappa^2 |V|}{\hbar^2}. \tag{13}$$

- Equation (13) turns out to be Besselian, and the mode functions are

$$\Psi_\nu(\beta,\chi) := \sum_{i=1}^{2} c_i \varphi_\nu^{(i)}(\gamma) \sum_{j=1}^{2} a_j \mathrm{B}_\nu^{(j)}(\sigma), \quad \nu \geq 0; \nu := \sqrt{\frac{2\varkappa}{3}\frac{1}{g}}\, k_\beta, \quad \gamma := \sqrt{\frac{3}{2\varkappa}\frac{g}{1}}\, \beta, \tag{14}$$

$${}_{(+,+)}\mathrm{B}_\nu^{(i)}(\sigma) := \mathrm{K} \text{ and } \mathrm{I}_{\mathbb{i}\nu}(\sigma), \qquad {}_{(+,-)}\mathrm{B}$$

$${}_{(-,+)}\mathrm{B}_\nu^{(i)}(\sigma) := \mathrm{J} \text{ and } \mathrm{Y}_\nu(\sigma), \qquad {}_{(-,-)}\mathrm{B}$$

- Adapted to imaginary order, $\mathrm{F}_\nu(\sigma)$ and $\mathrm{G}_\nu(\sigma)$ are defined in[5].

[5] T. Mark Dunster. In: *SIAM Journal on Mathematical Analysis* 21.4 (1990), pp. 995–1018.

Physical mode functions

233

- Physical mode functions are expected to be regular on the boundary.
- $(+,+)$: $|\mathrm{I}_{\mathbb{i}\nu}(\sigma)| \to +\infty$ as $\alpha \to +\infty$
- $(-,+)$:
  - $\forall n \in \mathbb{N}$, $|\mathrm{Y}_n(\sigma)| \to +\infty$ as $\alpha \to -\infty$.
  - $\forall \nu \in \mathbb{R}^+ \backslash \mathbb{N}$, choose $\mathrm{J}_{-\nu}$ instead of Y_ν, since $\mathrm{J}_{\pm\nu}$ are also linearly independent.
  - $\forall \nu \in \mathbb{R}^+ \backslash \mathbb{N}$, $|\mathrm{J}_{-\nu}(\sigma)| \to +\infty$ as $\alpha \to -\infty$.
- $(-,-)$: $|\mathrm{K}_\nu(\sigma)| \to +\infty$ as $\alpha \to -\infty$; $|\mathrm{I}_\nu(\sigma)| \to +\infty$ as $\alpha \to +\infty$
- These are not to be included in the space of physical wave functions. $\forall \nu \geq 0$,
  - $(+,+)$: $\mathrm{K}_{\mathbb{i}\nu}(\sigma)$ survives
  - $(+,-)$: F and $\mathrm{G}_{\mathbb{i}\nu}(\sigma)$ survives
  - $(-,+)$: $\mathrm{J}_\nu(\sigma)$ survives
  - $(-,-)$: drops out

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Matching quantum number with classical first integral

233

- Baustelle
- In order to match the quantum number k_β (or *linearly*, ν) with the classical first integral p_β, one may apply the *principle of constructive interference*.
- Writing the mode function in the WKB form

$$\Psi_{k_\beta}(\beta, \chi) \sim \sqrt{\rho}\, \mathbb{e}^{\mathbb{i} S/\hbar}, \qquad S/\hbar \gg 1 \text{ and } k_\beta \gg 1, \tag{15}$$

  the principle demands that $\partial S/\partial k_\beta = 0$ be equivalent to the classical trajectory.

Matching quantum number with classical first integral

$(+,+)$ as exemplar

- Fixing $\nu/\sigma > 1$, the asymptotic expansion reads

$$\mathrm{K}_{\mathbb{i}\nu}(\sigma) \sim \frac{\sqrt{2\pi}\cos\left(\sqrt{\nu^2-\sigma^2} - \nu \arccos\frac{\nu}{\sigma} - \frac{\pi}{4}\right)}{\left(\nu^2-\sigma^2\right)^{1/4}\mathbb{e}^{\pi\nu/2}} + O\left(\frac{1}{\sigma}\right). \tag{16}$$

- There are two phases with opposite signs. Assuming c, a are real and applying *the principle* to $\Psi_\nu(\sigma)$, one has$\sigma/\nu = \operatorname{sech}(\jmath_\beta\gamma)$, which matches the trajectory with $C = 0$ if

$$\hbar k_\beta \equiv \hbar\sqrt{\frac{3}{2\varkappa}g\hbar\nu} = p_\beta, \tag{17}$$

- Non-vanishing C can be compensated by the phase of c's and a's.
- Fixing $\nu/\sigma < 1$, the asymptotic expansion is not oscillatory, but exponential; it is not within the WKB regime.

- The conclusions also hold for $\mathrm{F}_{\mathbb{i}\nu}(\sigma)$, $\mathrm{G}_{\mathbb{i}\nu}(\sigma)$ for $(+,-)$, and $\mathrm{J}_\nu(\sigma)$ for $(-,+)$.

Inner product for wave functions

Schrödinger product

- To make sense of amplitude and wave packet, an inner product is necessary
- A common starting point of most approaches is the *Schrödinger product*

$$(\Psi_1, \Psi_2)_{\mathsf{S}} := \int \mathrm{d}\chi\, \Psi_1^*(\beta,\chi)\Psi_2(\beta,\chi); \tag{18}$$

- In terms of a norm, $(\Psi,\Psi)_{\mathsf{S}} \equiv \int \mathrm{d}\chi\, \rho_{\mathsf{S}}(\beta,\chi)$, in which $\rho_{\mathsf{S}} := \Psi^*\Psi$. Manifestly $\rho_{\mathsf{S}} \geq 0$; one has $(\Psi,\Psi)_{\mathsf{S}} > 0$.
- The corresponding Schrödinger current does not satisfy continuity equation $\dot{\rho}_{\mathsf{S}} + \nabla\cdot\vec{j}_{\mathsf{S}} = 0$, because eq. (11) is KG-like.
- $\mathrm{K}_{\mathring{\imath}\nu}$[6] for $(+,+)$, $\mathrm{F}_{\mathring{\imath}\nu}$ and $\mathrm{G}_{\mathring{\imath}\nu}$ for $(+,-)$ can be proved to be orthogonal and complete individually, as well as can be normalised.
    - $\mathrm{J}_{\mathring{\imath}\nu}$'s for $(+,-)$ are not orthogonal

[6] Semyon B. Yakubovich. In: *Opuscula Math.* 26.1 (2006), pp. 161–172, A. Passian et al. In: *Journal of Mathematical Analysis and Applications* 360.2 (2009), pp. 380–390, Radosław Szmytkowski and Sebastian Bielski. In: *Journal of Mathematical Analysis and Applications* 365.1 (2010), pp. 195–197.

Peculiarity of the phantom model $(-,+)$

Orthogonality for mode functions; Hermiticity for operators

- $\mathrm{J}_\nu(\sigma)$'s are not orthogonal under the Schrödinger product

$$(\mathrm{J}_\nu, \mathrm{J}_{\tilde{\nu}})_{\mathsf{S}} \propto \int_{-\infty}^{+\infty} \mathrm{d}x \, \mathrm{J}_\nu^*(\mathrm{e}^x) \mathrm{J}_{\tilde{\nu}}(\mathrm{e}^x) = \frac{2\sin(\pi(\nu-\tilde{\nu})/2)}{\pi(\nu^2-\tilde{\nu}^2)}, \tag{19}$$

  therefore $\mathbb{D}$ in eq. (13) is not Hermitian (though we do not need it so far)
- $\hat{p}_\chi^2$ is not Hermitian for $\{\mathrm{J}_\nu(\sigma)\}$ under the Schrödinger product

$$\int_{-\infty}^{+\infty} \mathrm{d}x \, \mathrm{J}_\nu^*(-\partial_x^2 \mathrm{J}_{\tilde{\nu}}) - \int_{-\infty}^{+\infty} \mathrm{d}x \, (-\partial_x^2 \mathrm{J}_\nu)^* \mathrm{J}_{\tilde{\nu}} = \frac{2}{\pi} \sin \frac{\pi(\nu-\tilde{\nu})}{2}. \tag{20}$$

- In order to save Hermiticity for p_χ^2 and $\mathbb{D}$ and orthogonality of the modes under Schrödinger product, one can restrict

$$\nu = 2n + \nu_0, \qquad n \in \mathbb{N}, \quad \nu_0 \in [0, 2) \, . \tag{21}$$

- The classical trajectory is β-even; imposing the same condition fixes $\nu_0 = 1$.

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Discritisation of the phantom model $(-,+)$
233

Levels of the phantom model are discretised

...if one imposes Hermiticity of squared momenta under the Schrödinger product

- This kind of subtlety on Hermiticity is named as *self-adjoint extension*, which arises already for infinite square well[7].
- It also applies to x^{-2} potentials[8], which is of cosmological relevance[9].

---

[7] Guy Bonneau, Jacques Faraut, and Galliano Valent. In: *American Journal of Physics* 69.3 (2001), pp. 322–331.

[8] Andrew M. Essin and David J. Griffiths. In: *American Journal of Physics* 74.2 (2006), pp. 109–117, Vanilse S. Araujo, F. A. B. Coutinho, and J. Fernando Perez. In: *American Journal of Physics* 72.2 (2004), pp. 203–213.

[9] Mariam Bouhmadi-López et al. In: *Physical Review D* 79.12 (2009).

Further inner products for wave functions

Klein–Gordon and Mostafazadeh product

- Since eq. (11) is KG-like, another popular choice is the KG product

$$(\Psi_1, \Psi_2)^g_{\mathsf{KG}} := \mathring{\imath} g \Big\{ \big(\Psi_1, \dot{\Psi}_2\big)_{\mathsf{S}} - \big(\dot{\Psi}_1, \Psi_2\big)_{\mathsf{S}} \Big\}, \quad g > 0. \tag{22}$$

  - ρ_{KG} is real but may go negative
  - Unique $\vec{J}_{\mathsf{KG}}$ exists such that $\dot{\rho}_{\mathsf{KG}} + \nabla \cdot \vec{J}_{\mathsf{KG}} = 0$.

- Mostafazadeh[10] found a inner products *for Hermitian* $\mathbb{D}$ *with positive spectrum*: $\forall \kappa > 0$,

$$(\Psi_1, \Psi_2)^\kappa_{\mathsf{M}} := \kappa \Big\{ \big(\Psi_1, \mathbb{D}^{+1/2} \Psi_2\big)_{\mathsf{S}} + \big(\dot{\Psi}_1, \mathbb{D}^{-1/2} \dot{\Psi}_2\big)_{\mathsf{S}} \Big\}, \tag{23}$$

  and $-1 < a < 1$.
  - ρ^κ_{M} may go complex
  - Unique $\vec{J}^\kappa_{\mathsf{M}}$ exists such that $\dot{\rho}^\kappa_{\mathsf{M}} + \nabla \cdot \vec{J}^\kappa_{\mathsf{M}} = 0$.

[10] Ali Mostafazadeh. In: *Classical and Quantum Gravity* 20.1 (2002), pp. 155–171.

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Mostafazadeh density
233

- It can be shown[11] that

$$\varrho^{\kappa}_{\mathsf{M}} := \kappa\left\{\left|\mathbb{D}^{+1/4}\Psi\right|^2 + \left|\mathbb{D}^{-1/4}\dot{\Psi}\right|^2\right\} \tag{24}$$

  satisfies
  - $\varrho^{\kappa}_{\mathsf{M}}$ is non-negative
  - $\int \mathbb{d}\chi\, \varrho^{\kappa}_{\mathsf{M}} = \int \mathbb{d}\chi\, \rho^{\kappa}_{\mathsf{M}} \equiv (\Psi_1, \Psi_2)^{\kappa}_{\mathsf{M}}$: it may be understood as a prob. density; but
  - The corresponding conserved $\vec{\mathcal{J}}^{\kappa}_{\mathsf{M}}$ does not exist.

[11] Ali Mostafazadeh and F. Zamani. In: *Annals of Physics* 321.9 (2006), pp. 2183–2209.

Issues
233

- A normalising κ for $(\cdot,\cdot)_{\mathsf{M}}^{\kappa}$ has not yet been able to be evaluated, hence a quantitative comparison of $(\cdot,\cdot)_{\mathsf{S}}$ and $(\cdot,\cdot)_{\mathsf{M}}^{\kappa}$ is not yet possible.

Outlook
233

- PT-symmetric instead of phantom field
- Cosmological perturbation

Integration of the transformed first Friedmann equation

$p_\beta \neq 0$

In order to integrate the equation under the implicitising gauge

$$\mathfrak{s}\frac{p_\beta^2}{12}\left(-\ell\frac{\varkappa^{1/2}}{6}\left(\frac{\mathrm{d}\chi}{\mathrm{d}\beta}\right)^2+\varkappa^{-1/2}\right)-\varkappa^{3/2}V\mathrm{e}^{g\mathfrak{s}_\chi\chi}=0, \tag{25}$$

one can substitute

$$\gamma := \sqrt{\frac{3}{2\varkappa}}g\beta, \qquad \tilde{\sigma}^2 := \frac{p_\beta^2}{12\varkappa^2|V|}\mathrm{e}^{-g\mathfrak{s}_\chi\chi}, \tag{26}$$

to get

$$\left(\frac{\mathrm{d}\tilde{\sigma}}{\mathrm{d}\gamma}\right)^2+\ell\left(\mathfrak{s}\mathfrak{v}-\tilde{\sigma}^2\right)=0 \quad \Rightarrow \quad \frac{\mathrm{d}\gamma}{\mathrm{d}\tilde{\sigma}}=\pm\frac{1}{\sqrt{\ell\left(-\mathfrak{s}\mathfrak{v}+\tilde{\sigma}^2\right)}}, \tag{27}$$

which is of the standard inverse hyperbolic / trigonometric form for $(+,+)$, $(+,-)$ and $(-,+)$.

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Integration of the separated mss. Wheeler–DeWitt equation 233

In order to integrate the separated minisuperspace Wheeler–DeWitt equation

$$\mathbb{D}\psi(\chi) = k_\beta^2\psi(\chi), \qquad \mathbb{D} := -\ell\frac{6}{\varkappa}\partial_\chi^2 + \jmath\upsilon\frac{12\varkappa^2|V|}{\hbar^2}, \tag{13 rev.}$$

one can transform

$$\nu := \sqrt{\frac{2\varkappa}{3}}\frac{k_\beta}{g}, \qquad \sigma^2 := \frac{8\varkappa^3|V|\mathrm{e}^{g\jmath_\chi\chi}}{\hbar^2 g^2}, \tag{14 rev.}$$

to get

$$\sigma^2\psi''(\sigma) + \sigma\psi'(\sigma) + \ell(\nu^2 - \jmath\upsilon\sigma^2)\psi(\sigma) = 0, \tag{28}$$

which is of the standard Besselian form.

Andrianov, Lan, Novikov, Wang
SPBU, ELI-ALPS, UzK, UB

Allgemeines

- Mit diesem *beamer theme* ist es möglich, Präsentationen in LaTeX mit der Beamer-Klasse zu erstellen, die dem Corporate Design der Universität zu Köln entsprechen
- Auf die Beamer-Klasse wird in diesem Dokument nicht näher eingegangen, nähere Informationen finden Sie unter `http://latex-beamer.sourceforge.net/`

Laden des Themes

Das Theme kann mit den folgenden Optionen geladen werden

```
\usetheme[%
% uk,      %% Farben aller Fakultaeten
wiso,     %% Wiso-Fakultaet
% jura,    %% Rechtswissenschaftliche Fakultaet
% medizin, %% Medizinische Fakultaet
% philo,   %% Philosophische Fakultaet
% matnat,  %% Mathematisch-Naturwissenschaftliche Fakultaet
% human,   %% Humanwissenschaftliche Fakultaet
% verw,    %% Universitaetsverwaltung
]{UzK}
```

Die Fußzeile

- Es stehen verschiedene Fußzeilen zur Auswahl, die als Option beim Laden des *themes* übergeben werden:
  - Balken mit allen Fakultätsfarben (Option `uk`)
  - Balken in jeweils einer Fakultätsfarbe (Optionen `wiso`, `jura`, `medizin`, `philo`, `matnat`, `human`, `verw`)[12]
- "'Universität zu Köln"' sowie der Name der Fakultät sind im Theme definiert, das Institut oder Seminar kann mit dem Befehl `\institute{}` festgelegt werden
- Die Optionen sind im Quellcode dieser Präsentation dokumentiert

[12] Es werden die offiziellen RGB-Werte aus dem 2-D Handbuch Corporate Design verwendet.

Englische Präsentationen

- Der Universitäts- sowie die Fakultätsnamen werden standardmäßig auf Deutsch angezeigt.
- Übergeben Sie dem Paket `babel` die Option `english`, so werden diese Namen entsprechen angepasst.
- Die Übersetzungen können in der Theme-Datei `beamerthemeUzK.sty` geändert werden

block-Umgebungen

Standard (block)

Verwendet die Farbe "'Blaugrau Mittel"' als Blocktitel-Hintergrund

exampleblock

Bei Verwendung der Fußzeile mit allen Fakultätsfarben Titelhintergrund in Wiso-Grün, sonst in der jeweiligen Fakultätsfarbe

alertblock

Verwendet das Rot der Folientitel

Installation

- Das Theme besteht aus den Dateien `beamerthemeUzK.sty` und `beamercolorthemeUzK.sty` sowie den Grafikdateien `logo.pdf` und `logo-small.pdf`.
- Das Theme kann auf zwei Arten verwendet werden:
  1. Die vier Dateien werden in den selben Ordner wie die zu erstellende Präsentation gelegt
  2. Die vier Dateien werden im lokalen *texmf*-Baum abgelegt
- Die zweite Variante ist der ersten vorzuziehen, da das Theme so an einem zentralen Ort vorliegt

ToDo

Was noch zu tun ist...

- Erstellen einer eigenen Titelseite
- ...