C. R. Acad. Sci. Paris, Ser. I 334 (2002) 489–494

Systémes dynamiques/*Dynamical Systems*
(Analyse complexe/*Complex Analysis*)

On simultaneous uniformization and local nonuniformizability

Alexey Glutsyuk

CNRS, Unité de mathématiques pures et appliquées, MR, École normale supérieure de Lyon, 46, allée d'Italie, 69364 Lyon cedex 07, France

Received 17 December 2001; accepted 7 January 2002

Note presented by Étienne Ghys.

Abstract We prove existence of a one-dimensional holomorphic foliation (with isolated irremovable singularities) tangent to a rational vector field on appropriate affine algebraic surface of dimension 2 such that the family of leaves intersecting arbitrary given cross-section does not admit a uniformization holomorphic in the parameter by a family of simply connected domains in $\overline{\mathbb{C}}$. We show that such a foliation can be chosen transversally affine, having a Liouvillian first integral, with dense and hyperbolic leaves and an attracting cycle. This extends the author's result [4] giving a negative answer to Ilyashenko's simultaneous uniformization conjecture and answers negatively to the local version of this conjecture recently proposed by Shcherbakov. ***To cite this article: A. Glutsyuk, C. R. Acad. Sci. Paris, Ser. I 334 (2002) 489–494.*** © 2002 Académie des sciences/Éditions scientifiques et médicales Elsevier SAS

Sur uniformisation simultanée et nonuniformisabilité locale

Résumé On montre l'existence d'un feuilletage holomorphe de dimension un (à singularités isolées non effaçables) sur une surface algébrique affine lisse appropriée de dimension 2 qui est tangent à un champ vectoriel rationnel, et tel qu'aucune famille de feuilles intersectant une section transverse n'admet d'uniformisation holomorphe paramétrée par une famille d'ouverts simplement connexes de $\overline{\mathbb{C}}$. On montre, qu'un tel feuilletage peut être choisi transversalement affin, ayant une intégrale première de type Liouville, toutes les feuilles hyperboliques et denses et un cycle attractif. Cela étend le résultat précédent de l'auteur (donnant la réponse négative à la conjecture d'Ilyachenko sur l'uniformisation simultanée) et répond négativement à une version locale de cette conjecture proposée récemment par Chtcherbakov. ***Pour citer cet article : A. Glutsyuk, C. R. Acad. Sci. Paris, Ser. I 334 (2002) 489–494.*** © 2002 Académie des sciences/Éditions scientifiques et médicales Elsevier SAS

Version française abrégée

Soit S une surface affine (projective) algébrique lisse de dimension 2, F un feuilletage holomorphe de dimension un sur S (à singularités isolées noneffaçables), qui est tangent à un champ vectoriel rationnel. Bref, on dit dans ce cas que F est *algébrique affine* (*projectif*).

Grosso modo, le résultat principal de la note est l'existence d'un tel feuilletage F pour lequel, une section locale transverse D arbitraire étant fixée, la famille de feuilles de F intersectant D ne peut pas être

E-mail address: aglutsyu@umpa.ens-lyon.fr (A. Glutsyuk).

uniformisée de manière holomorphe par une famille d'ouverts simplement connexes de $\overline{\mathbb{C}}$. Pour formuler ce résultat, introduisons la définition suivante.

DÉFINITION 1. – Soit S, F comme ci-dessus, $D \subset S$ une section transverse simplement connexe (pas forcément globale). Pour un $z \in D$ notons L_z la feuille de F contenant z. La *variété de revêtements universels* (bref, v.r.u) associée à D est $M_D = \bigcup_{z \in D}$(revêtement universel de L_z à point de base z).

L'espace M_D admet une structure naturelle de variété complexe, si et seulement s'il est Hausdorff. Si S est affine, c'est une variété d'après un théorème de Yu.S. Ilyachenko [6,8], qui a également montré, que M_D est Stein. Dans le cas, où S est projective, cela n'est pas vrai en général (un exemple, où M_D n'est pas Hausdorff, a été proposé par le référé de la note). C'est vrai dans ce deuxieme cas, s'il n'y a pas de feuilles de F du type sphère épointée (un corollaire d'un remarque de Tchirka et d'une version du théorème de Gromov [5] de compacité). On ne sait pas dans ce cas, si M_D est toujours Stein, s'il est une variété. L'espace M_D admet une projection holomorphe naturelle $p : M_D \to D$ (s'il est une variété). On dit que M_D est *uniformisable*, s'il existe un biholomorphisme de M_D sur un ouvert dans $D \times \overline{\mathbb{C}}$ qui forme un diagramme commutatif avec les projections.

THÉORÈME 1. – *Il existe un feuilletage F affine algébrique pour lequel toute v.r.u. est non uniformisable. On peut choisir un tel F satisfaisant les conditions supplémentaires suivantes* : (1) *F est transversalement affine et a une intégrale première de type Liouville*; (2) *toute feuille est dense et hyperbolique*; (3) *certaine feuille contient un cycle attractif*; (4) *l'adhérence projective $\overline{S}$ de la variété feuilletée est lisse, et F s'étend à un feuilletage algébrique sur $\overline{S}$ pour lequel toute v.r.u. est une variété complexe et n'est pas uniformisable.*

1. Main result and historical remarks

Let S be an affine (or projective) smooth algebraic surface of dimension 2, F be a one-dimensional holomorphic foliation on S (with isolated irremovable singularities) tangent to a rational vector field. In this case we say briefly that F is *algebraic affine* (*projective*).

Remark 1. – Let S, F be as above, S be affine and its projective closure $\overline{S}$ be smooth. Then F extends up to an algebraic foliation on $\overline{S}$ (called *the projective extension*, denoted $\overline{F}$).

Roughly speaking, the principal result of the paper is the existence of S, F as above such that the family of leaves intersecting arbitrary given cross-section does not admit a uniformization holomorphic in the parameter by a family of simply connected domains in the Riemann sphere. To state this result precisely, let us introduce the following

DEFINITION 1. – Let S, F be as above, $D \subset S$ be a simply connected (may be not global) transversal cross-section to F *containing no singularities*. For any $z \in D$ denote L_z the leaf of F passing through z. The *universal covering manifold* (briefly, *u.c.m.*) associated to D is

$$M_D = \bigcup_{z \in D} (\text{universal covering of } L_z \text{ with the base point } z).$$

Remark 2. – The space M_D admits a natural structure of complex manifold, if and only if it is Hausdorff. If S is affine, M_D is a manifold by Ilyashenko's theorem [6,8] who also showed that M_D is Stein. If S is projective, this is wrong in general (an example where M_D is not Hausdorff was proposed by the referee). But if in this second case no leaf of F is a once punctured sphere, then each its u.c.m. is a manifold. This follows from a remark of E. Chirka and a version of Gromov compactness theorem [5]. It is not known in the second case, whether M_D is always Stein whenever it is a manifold.

The manifold M_D admits a natural holomorphic projection $p : M_D \to D$ and a section $D \to M_D$ inverse to p defined by taking the base points of the universal coverings.

DEFINITION 2. – A u.c.m. M_D is said to be *uniformizable*, if it admits a biholomorphism onto a domain in $D \times \overline{\mathbb{C}}$ that forms a commutative diagram with the projections. It is said to be *locally uniformizable* at a given point $z \in D$, if its restriction to a neighborhood U of z (which coincides with the universal covering manifold M_U) is uniformizable.

THEOREM A. – *There exists an affine algebraic foliation with no uniformizable u.c.m.*

COROLLARY. – *For a foliation from Theorem A each u.c.m. is nowhere locally uniformizable.*

ADDENDUM TO THEOREM A. – *In Theorem A the foliation* (*denoted by* F) *can be chosen to have the following additional properties*:

(1) F *is transversally affine and admits a Liouvillian first integral* (*cf.* (5)) *below*);
(2) *each leaf is dense and hyperbolic: its universal covering is conformally equivalent to disc;*
(3) *some leaf contains an attracting cycle* (*a closed curve with an attracting return mapping*);
(4) *the projective extension* $\overline{F}$ *is well-defined, each its u.c.m. a manifold and nonuniformizable*;
(5) F *is a rational pullback of the foliation on* $\mathbb{C} \times (\mathbb{C} \setminus \pm 1)$ *with a first integral* $I(z,w) = z(1-w)^{\alpha} + \beta \int_0^w \frac{(1-\tau)^{\alpha}}{\tau+1}\,\mathrm{d}\tau$.

Theorem A is proved in Sections 2 and 3.

In late 1960s Yu.S. Ilyashenko proposed the conjecture saying that each u.c.m. of any algebraic foliation is uniformizable. He proved uniformizability of certain u.c.m's [7]. At the end of 1999 a negative answer in the general case was proved by the author [4]. His counterexample was locally uniformizable at a generic point. In 2001 A.A. Shcherbakov proposed the conjecture saying that each u.c.m. of any algebraic foliation with hyperbolic leaves is locally uniformizable. Theorem A, Corollary and Addendum give a negative answer.

2. The plan of the proof of Theorem A, previous results and open questions

2.1. *The plan of the proof of Theorem* A. –

DEFINITION 3. – An affine algebraic foliation is *geometrically nice*, if it satisfies the statements (1)–(3), (5) of the Addendum (in particular, it has a dense leaf with an attracting cycle).

DEFINITION 4. – Let F be an algebraic foliation, D be a simply connected cross-section such that some leaf contains an attracting cycle starting at a point $0 \in D$ with a well-defined Poincaré return mapping $h : D \to D$ (then $h(0) = 0$). Let $hD \Subset D$. Then we say that D is (h-)*contracting*. In this case the corresponding u.c.m. M_D is also said to be *contracting*.

THEOREM 1. – *There exists a geometrically nice foliation* F *having at least one nonuniformizable contracting u.c.m.* M_D. *They can be chosen so that the projective extension* $\overline{F}$ *is well-defined, each its u.c.m. is a manifold, and the u.c.m. corresponding to* $\overline{F}$ *and the same cross-section* D, *as* M_D, *is nonuniformizable.*

Remark 3. – The second statement of Theorem 1 is used only in the proof of statement (4) of the Addendum. Its sketch-proof is given in Section 3.3.

The first part of Theorem 1 is the principal step in the proof of Theorem A. It is proved in Section 3. The second step in the proof is to show that in fact, in Theorem 1 no u.c.m. is uniformizable, by using density of the leaf with an attracting cycle and the following

PROPOSITION 1. – *Let an algebraic foliation have a nonuniformizable contracting u.c.m.* M_D, $0 \in D$ *be the starting point of the corresponding attracting cycle. Then* M_D *is locally nonuniformizable at* 0.

Proposition 1 is proved below. In the proofs of Proposition 1 and Theorem A we use the following relation between universal covering manifold and holonomy.

Remark 4. – Let F be an algebraic foliation, D, D' be cross-sections isomorphic under some holonomy mapping: there is a family of paths from the points of D to D' contained in the leaves of F and depending continuously on their starting points in D such that the (holonomy) mapping $h : z \mapsto z'$, defined by taking the end-point z' of the path starting at z, is a conformal isomorphism $D \to D'$. Then there is a natural biholomorphic isomorphism $M_D \to M_{D'}$ of the corresponding u.c.m's that forms a commutative diagram with the projections and h.

Proof of Proposition 1. – The iterations h^n converge to 0 uniformly in D, as $n \to +\infty$ (since $hD \Subset D$). For any $n \in \mathbb{N}$ the u.c.m. $M_{h^n D}$ corresponding to the smaller cross-section $h^n D$ is isomorphic to M_D, see Remark 4. Since M_D is nonuniformizable by assumption, so is $M_{h^n D}$. This together with the uniform convergence $h^n \to 0$ implies Proposition 1.

Proof of Theorem A. – Let F, M_D be as in Theorem 1. By assumption, each leaf of F is dense and D is contractible. Let $0 \in D$ be the starting point of the corresponding cycle, L be the leaf of F containing 0. By Proposition 1, M_D is locally nonuniformizable at 0. By Remark 4, for any cross-section D' intersecting L $M_{D'}$ is locally nonuniformizable at the points of the intersection $D' \cap L$. Now density of L implies Theorem A. Statement (4) of the Addendum follows analogously from the second statement of Theorem 1.

2.2. *Previous results on uniformizability.* – Bers' simultaneous uniformization theorem [3] implies that for any projective foliation F with everywhere defined rational first integral R for any section D disjoint from critical curves $R = \text{const}$ M_D is uniformizable. Ilyashenko [7] proved uniformizability of M_D for the above F when D intersects just once a unique critical curve $R = c$, if the latter contains only Morse critical points of R and no spherical leaf with either one or two punctures. Results of Nishino [10] and Ilyashenko [6,8] imply that for any affine foliation with all the leaves parabolic each M_D is equivalent to $D \times \mathbb{C}$ and hence uniformizable.

2.3. *Open questions.* – 1. – Describe the algebraic foliations F on $\mathbb{C}^2$ ($\mathbb{P}^2$) for which any u.c.m. M_D is isomorphic to the product of D and unit disc.

2. – Let F be a projective foliation with a rational first integral R, D be a section intersecting just once a unique critical level curve of R (now its critical points are not necessarily Morse). Is it true that M_D is uniformizable, whenever it is a manifold?

3. Proof of Theorem 1

3.1. *The plan of the proof of Theorem* 1. – Let us introduce the following

DEFINITION 5 ([4,9]). – Let D be a simply-connected domain in $\mathbb{C}$, M be a two-dimensional complex manifold, $p : M \to D$ be a holomorphic surjection having nonzero derivative. We say that the triple (M, p, D) is a *skew cylinder* with the base D and the total space M, if

(1) the level sets of the mapping p are connected and simply connected holomorphic curves;

(2) M has a holomorphic section: a holomorphic mapping $i : D \to M$, $p \circ i = \text{Id}$.

The definition of a *uniformizable* skew cylinder coincides with that of a uniformizable u.c.m. A skew cylinder is said to be *Stein*, if its total space is Stein. A u.c.m. corresponding to an algebraic foliation is a skew cylinder, whenever it is a manifold. It is Stein, if the foliation is affine (Ilyashenko's theorem [6,8]).

The proof of Theorem 1 is based on the construction of an abstract nonuniformizable Stein skew cylinder done in [4] and recalled in the following lemma.

Everywhere below we suppose that D is unit disc in complex line with the coordinate z. By $\pi : D \times \mathbb{C} \to D$ we denote the left projection.

DEFINITION 6. – A domain $V \subset D \times \mathbb{C}$ is said to be a *uniformizable skew annulus* (or briefly, u.s.a.), if it satisfies the following conditions:

(1) each its fiber $\pi^{-1}(z) \cap V$ is either a once punctured complex line, or a complement to a disc;

(2) $V \supset D \times c$ for any $c \in \mathbb{C}$ large enough.

Remark 5. – The universal covering (denoted by M^V) over a u.s.a. V admits a natural structure of skew cylinder with the base D. It is Stein, if V is Stein. This follows from the theorem due to Stein [12] saying that a covering over a Stein manifold is Stein.

LEMMA 1 ([4]). – *There exists a Stein u.s.a. with a nonuniformizable universal covering.*

Remark 6. – It is easy to construct a u.s.a. with a nonuniformizable universal covering that is not Stein (*cf.* example 2 in [4]). Lemma 1 was proved in [4] for the u.s.a. that is the complement to a nontrivial set constructed by Bo Berndtsson and T.J. Ransford [2].

DEFINITION 7 ([4,11]). – Let (M, p, D) be a skew cylinder, $B \subset M$ ($B \Subset M$) be its subdomain. Then B is called a (*compact*) *subcylinder*, if the triple $(B, p, p(B))$ is a skew cylinder.

DEFINITION 8 ([4]). – Two skew cylinders are said to be *equivalent*, if there exist biholomorphisms of their total spaces and bases that form a commutative diagram with the projections.

The first statement of Theorem 1 is proved below; a sketch-proof of the second one is given in 3.3. In the proof of Theorem 1 we use the two following statements.

PROPOSITION 2 (by Ilyashenko, see [11]). – *Let a Stein skew cylinder be exhausted by increasing sequence of uniformizable subcylinders. Then it is uniformizable.*

LEMMA 2 (proved in Section 3.2). – *For any Stein u.s.a. any compact subcylinder of its universal covering is equivalent to a subcylinder of a contracting u.c.m. corresponding to a geometrically nice foliation.*

Proof of the first statement of Theorem 1. – Let V be a Stein u.s.a. with a nonuniformizable universal covering M^V. By Proposition 2, M^V contains a nonuniformizable compact subcylinder B. By Lemma 2, B is equivalent to a subcylinder of a contracting u.c.m. of a geometrically nice foliation. The latter u.c.m. is nonuniformizable as well.

3.2. *Proof of Lemma* 2. – For the proof of Lemma 2, we consider the foliation on $\mathbb{C} \times (\mathbb{C} \setminus \pm 1)$ (denoted by $F_{\alpha,\beta}$) with the first integral $I(z, w) = z(1-w)^{\alpha} + \beta \int_0^w \frac{(1-\tau)^{\alpha}}{\tau+1}\,\mathrm{d}\tau$. (The foliation $F_{\alpha,\beta}$ tends to the parallel line fibration $z = \text{const}$, as $\alpha, \beta \to 0$.) Then the line $\mathbb{C} \times 0$ is a global transversal section.

PROPOSITION 3. – *The foliation $F_{\alpha,\beta}$ is algebraic and transversally affine. If $\alpha \notin \mathbb{R} \cup \mathrm{i}\mathbb{R}$, $\beta \neq 0$, then its leaves are dense* (*then $F_{\alpha,\beta}$ is geometrically nice*). *Let $h_+ : \mathbb{C} \times 0 \to \mathbb{C} \times 0$ be the first return mapping corresponding to $F_{\alpha,\beta}$ and the counterclockwise circuit in $\mathbb{C}$ going around 1 and starting at 0. The mapping h_+ is linear* (*not necessarily homogeneous*) *with the derivative* $\mathrm{e}^{-2\pi \mathrm{i}\alpha}$. *If* $\operatorname{Im}\alpha < 0$, *then h_+ is a contraction and its fixed point is* $\mathrm{O}(\beta)$, *as $\alpha, \beta \to 0$.*

Let V be a given Stein u.s.a., $B \Subset M^V$ be a fixed compact subcylinder, $\alpha \notin \mathbb{R} \cup \mathrm{i}\mathbb{R}$, $\operatorname{Im}\alpha < 0$, $\beta \neq 0$, cf. Proposition 3. We show that if α, β are small enough and β is small enough dependently on B and α, there exist a smooth affine surface S and a rational mapping $P : S \to \mathbb{C} \times (\mathbb{C} \setminus \pm 1)$ with nowhere degenerate Jacobian matrix such that the subcylinder B and the foliation $F = P^* F_{\alpha,\beta}$ satisfy the statements of Lemma 2 (F is geometrically nice, since so is $F_{\alpha,\beta}$ (Proposition 3), the Jacobian matrix of P is nondegenerate and the number of preimages of P is uniformly bounded). Let $\phi : M^V \to V$ be the projection of the universal covering. To construct S, P as above, fix an $R > 0$ such that $\phi(B) \subset \{|w| < R - 3\}$ and $D \times \{|w| \geqslant R - 3\} \subset V$ (this is true for any R large enough). Consider the auxiliary domain

$$V_R = (V + (0, R)) \setminus (D \times \pm 1) \subset \mathbb{C}^2; \quad \text{then } D \times 0 \subset V_R,\ \phi(B) + (0, R) \Subset V_R.$$

Fix a disc $D' \Subset D$ centered at 0 such that $\pi(\phi(B)) \Subset D'$. Replace the parallel line fibration $z = \text{const}$ of V_R by the restriction to V_R of the foliation $F_{\alpha,\beta}$. Denote by $M_{D'}(\alpha, \beta)$ the u.c.m. associated to thus foliated manifold V_R and the cross-section $D' \times 0$.

LEMMA 3. – *Let V, B, $F_{\alpha,\beta}$, R, V_R, D', $M_{D'}(\alpha, \beta)$ be as above* (*V, B, R, D' are fixed, no inequalities on α, β*). *If α, β are small enough* (*dependently on B, R, D'*), *then B is equivalent to a compact subcylinder of $M_{D'}(\alpha, \beta)$* (*briefly, $B \Subset M_D(\alpha, \beta)$*). *If in addition* $\operatorname{Im}\alpha < 0$, *$\beta$ is small enough* (*dependently on α, D'*), *then the section $D' \times 0$ is h_+-contracting.*

Sketch-proof. – Let us prove that $B \Subset M_{D'}(\alpha, \beta)$. The domain V_R is Stein. If $\alpha = \beta = 0$, then $M_{D'}(\alpha, \beta) = M_{D'}(0, 0)$ is the universal covering of V_R. A lifting to $M_{D'}(0, 0)$ of the mapping $\phi + (0, R)$:

$B \to V_R$ is an embedding $B \Subset M_{D'}(0,0)$. The statement that $B \Subset M_{D'}(\alpha,\beta)$ for any small α, β is implied by its previous version and the following

LEMMA 4. – *Let W be a Stein manifold of arbitrary dimension, Φ_0 be a one-dimensional holomorphic foliation on W (with the set of irremovable singularities (denote it by Σ) contained in an analytic set of complex codimension at least 2: then Φ_0 is said to be* admissible).

Let $D \subset W$ be a cross-section, M_D be the corresponding u.c.m., $B \Subset M_D$ be a compact subcylinder. Then for any other admissible foliation Φ on W close enough to Φ_0 in the topology of uniform convergence on compact sets in $V \setminus \Sigma$ the cylinder B is equivalent to a compact subcylinder of the u.c.m. corresponding to D and the new foliation Φ.

In the conditions of Lemma 4 M_D is always a Stein manifold [6,8]. Its proof is analogous to the discussion from Subsection 2.4 of [4]; it uses statement (S) from the same place.

Let B, R, α, β satisfy all the statements of Proposition and Lemma 3: then $B \Subset M_{D'}(\alpha,\beta)$ (denote by $\widetilde{B}$ the image of B under the natural mapping $M_{D'}(\alpha,\beta) \to V_R$). To construct S, P, F, we consider the Stein manifold V_R as a submanifold in $\mathbb{C}^N$ so that the natural inclusion $V_R \to \mathbb{C}^2$ is the restriction to V_R of an orthogonal projection (denoted by P). Let V^r be the intersection of V_R with a ball centered at 0 of a large radius r such that $V^r \supset (\overline{\widetilde{B}} \cup (\overline{D'} \times 0))$. We approximate $\overline{V^r}$ by a smooth affine algebraic surface S' using results of [1] (*cf.* [4]) so that $P|_{S'}$ has an inverse holomorphic (denoted by $(P|_{S'})^{-1}$) on $P(V^r)$. Let $S = S' \setminus (\mathrm{Crit}(P|_{S'}) \cup \{w \circ P = \pm 1\})$, $\widetilde{D} = (P|_{S'})^{-1}(D' \times 0)$. The foliation $F = (P|_S)^* F_{\alpha,\beta}$ is the one we are looking for, if r is large enough: $\widetilde{D}$ is a contracting cross-section to F and B is embedded to $M_{\widetilde{D}}$ as a subcylinder under the natural mapping $B \to M_{\widetilde{D}}$ induced by $(P|_{S'})^{-1} \circ P|_{V^r}$. This proves Lemma 2.

3.3. *Sketch-proof of the second statement of Theorem* 1. – One can do the previous construction so that $\overline{S}$ is smooth and no leaf of $\overline{F}$ is a punctured sphere: then each its u.c.m. is a manifold (*cf.* Remark 2). By $\widetilde{M}_{\widetilde{D}}$ denote the u.c.m. corresponding to $\overline{F}$ and the previous section $\widetilde{D}$. Then $B \Subset \widetilde{M}_{\widetilde{D}}$; thus, the latter is nonuniformizable, if so is B.

Acknowledgements. I am grateful to Yu.S. Ilyashenko and A.A. Shcherbakov, who had drawn my attention to the problem, and also to them and G.M. Henkin for helpful discussions. The referee of the paper have read it carefully, made very important remarks and inspired major improvements. I wish to thank him for helpful interaction. Research supported by part by CRDF grant RM1-2086, by INTAS grant 93-0570-ext, by Russian Foundation for Basic Research (RFBR) grant 98-01-00455. The main results were obtained during my visit to Moscow that was partially supported by CCCI travel grant.

References

[1] C. Bănică, O. Forster, Complete intersections in Stein manifolds, Manuscripta Math. 37 (3) (1982) 343–356.
[2] Bo Berndtsson, T.J. Ransford, Analytic multifunctions, the $\overline{\partial}$-equation, and a proof of the corona theorem, Pacific J. Math. 124 (1) (1986) 57–72.
[3] L. Bers, Simultaneous uniformization, Bull. Amer. Math. Soc. 66 (1960) 94–97.
[4] A. Glutsyuk, Nonuniformizable skew cylinders. A counterexample to the simultaneous uniformization problem, C. R. Acad. Sci. Paris, Série I 332 (3) (2001) 209–214.
[5] M. Gromov, Pseudoholomorphic curves in symplectic manifolds, Invent. Math. 82 (2) (1985) 307–347.
[6] Yu.S. Ilyashenko, Foliations by analytic curves, Mat. Sb. 88 (130) (1972) 558–577.
[7] Yu.S. Ilyashenko, Nondegenerate B-groups, Soviet Math. Dokl. 14 (1973) 207–210.
[8] Yu.S. Ilyashenko, Covering manifolds for analytic families of leaves of foliations by analytic curves, Topol. Methods Nonlinear Anal. 11 (2) (1998) 361–373.
[9] Yu.S. Ilyashenko, A.A. Shcherbakov, Skew cylinders and simultaneous uniformization, Proc. Steklov Inst. Math. 213 (1996) 112–123.
[10] T. Nishino, Nouvelles recherches sur les fonctions entières de plusieurs variables complexes (II). Fonctions entières qui se reduisent à celles d'une variable, J. Math. Kyoto Univ. 9 (2) (1969) 221–274.
[11] A.A. Shcherbakov, The exhaustion method for skew cylinders, Algebra i Analiz 12 (5) (2000) 178–206.
[12] K. Stein, Überlagerungen holomorph-vollständiger komplexer Räume, Arch. Math. 7 (5) (1956) 354–361.